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Kansas State Agricultural College

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BULLETIN

OF THE

DIVISION OF MECHANIC ARTS

ANNOUNCEMENTS
1914-1915

MANHATTAN

THE KANSAS INDUSTRIALIST, VOL. XL, NO. 42

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The Board of Administration

The Hon. ED. T. HACKNEY, *President* Wellington, Sumner county.	Term expires 1917
The Hon. E. W. HOCH Marion, Marion county.	Term expires 1915
The Hon. (Mrs.) CORA G. LEWIS Kinsley, Edwards county.	Term expires 1917

D. M. Bowen, *Secretary.*
Pittsburg, Crawford county.

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The College Calendar

1914.

Sept. 14, Monday.—Faculty meeting at nine A. M.
Sept. 14, Monday.—Meeting of assigners at ten A. M.
Sept. 14, Monday.—Assignment of students begins at one-thirty P. M.
Sept. 14, Monday.—Admission of new students at one-thirty P. M.
Sept. 17, Thursday.—Assignment of students closes at five P. M.
Sept. 17, Thursday.—Short course for housekeepers begins
Sept. 18, Friday.—All classes meet according to schedule.
Sept. 18, Friday.—Opening convocation at ten A. M.
Oct. 10, Saturday.—Scholarship deficiency reports due
Oct. 31, Saturday.—Scholarship deficiency reports due
Nov. 26 to 28, Thursday to Saturday.—Thanksgiving vacation
Dec. 5, Saturday.—Examinations to remove conditions
Dec. 11 to 18, Friday to Friday.—Examinations at close of term
Dec. 18, Friday.—Fall term closes at eleven A. M.
Dec. 14, Monday.—Assignment of students for winter term begins at nine A. M.

1915.

Jan. 4, Monday.—Admission of new students at nine A. M.
Jan. 5, Tuesday.—Assignment of students closes at five P. M.
Jan. 5, Tuesday.—Short courses in agriculture and mechanic arts begin
Jan. 6, Wednesday.—All classes meet according to schedule
Jan. 30, Saturday.—Scholarship deficiency reports due
Feb. 20, Saturday.—Scholarship deficiency reports due
Mar. 13, Saturday.—Examinations to remove conditions
Mar. 17, Wednesday.—Short courses in agriculture and mechanic arts close
Mar. 19 to 26, Friday to Friday.—Examinations at close of term
Mar. 26, Friday.—Winter term closes at eleven A. M.
Mar. 22, Monday.—Assignment of students for the spring term begins at nine A. M.

Mar. 29, Monday.—Admission of new students at nine A. M.
Mar. 30, Tuesday.—Assignment of students closes at five P. M.
Mar. 31, Wednesday.—All classes meet according to schedule
Apr. 17, Saturday.—Scholarship deficiency reports due
May 8, Saturday.—Scholarship deficiency reports due
June 5, Saturday.—Examinations to remove conditions
June 9 to 16, Wednesday to Wednesday.—Examinations at close of term
June 13 to 17, Sunday to Thursday.—Exercises of Commencement Week
June 17 to July 29, Thursday to Thursday.—Summer School in session

Sept. 13, Monday.—Assignment of students begins at one-thirty P. M.
Sept. 16, Thursday.—Assignment of students closes
Sept. 17, Friday.—All classes meet according to schedule

Students must be present the very first day of each term or render a reasonable excuse. Failure to take out an assignment is not accepted as an excuse for absence from classes.

THE BOARD OF INSTRUCTION IN THE DIVISION OF MECHANIC ARTS

H. J. Waters	President of the College
A. A. Potter	Dean of the Division

J. D. Walters	Professor of Architecture and Drawing
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W. W. Carlson	Associate Professor of Shop Practice

W. C. Lane	Assistant Professor of Electrical Engineering
H. H. King	Assistant Professor of Chemistry
——	Assistant Professor of Farm Architecture

F. C. Harris	Instructor in Architecture and Drawing
P. J. Freeman	Instructor in Applied Mechanics
F. F. Frazier	Instructor in Civil Engineering
M. R. Bowerman	Instructor in Machine Design
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J. H. Hollar	Instructor in Forging
T. Hayes	Instructor in Machine Tool Work
E. Grant	Instructor in Molding
C. Coith-Nelson	Instructor in Drawing

J. T. Parker	Assistant in Woodwork
C. Yost	Assistant in Machine Shop
W. H. Sanders	Assistant in Farm Motors
J. C. Shutt	Assistant in Steam and Gas Engineering
W. A. Turnbull	Assistant in Blacksmithing
W. Ball	Assistant in Woodwork
W. A. Lathrop	Assistant in Blacksmithing
H. R. Brakeman	Assistant in Woodwork
A. Holman	Assistant in Drawing
G. C. Averill	Assistant in Drawing
S. A. Smith	Assistant in Drawing

F. Pattison	Fellow in Steam and Gas Engineering

Requirements for Admission

The entrance requirements to the College are made broad and flexible, only fundamental subjects being definitely required. These requirements are made upon the supposition that high schools are local institutions in which the courses should be adapted to the needs of the individual localities, and that college entrance requirements should be such as to take the output of the high schools, rather than to determine the nature of the work offered in them.

Persons, to be admitted to any department of the College, must be at least fourteen years of age. Fifteen units of high-school work are required for admission to the freshman class. A unit is defined to be the work done in an accredited high school or academy in five recitation periods a week for one school year. All persons who offer fifteen units of work done in an accredited high school, and accepted by such high school for graduation, will be admitted to the freshman class. One who offers fourteen such units will also be admitted as a freshman, but will be conditioned in one unit. Such deficiency must be made up the first year that the student is in attendance. If not made up within that time college credits are taken in its place.

For courses in the divisions of agriculture, home economics or general science the high-school work offered must include three units of English, two units of mathematics, and one unit of physics. For courses in the division of mechanic arts the high-school work offered must include, in addition to the preceding, another unit of mathematics. Students lacking any of these must make them up before graduation, and before being assigned to dependent subjects.

It is recommended that all high-school students planning to enter the College include a year of botany in their high-school course.

ENTRANCE SUBJECTS

The subjects from which entrance credit may be offered, together with the number of units, are arranged in eight groups, as follows:

GROUP I English	Three or four units
GROUP II Foreign Languages	Latin, one, two, three, or four units Greek, one, two, three, or four units German, one, two, three, or four units French, one, two, three, or four units Spanish, one, two, three, or four units

GROUP III Mathematics	Elementary Algebra, one or one and one-half units. Plane Geometry, one unit Solid Geometry, one-half unit. Plane Trigonometry, one-half unit Advanced Algebra, one-half unit
GROUP IV Natural Sciences	Physical Geography, one-half or one unit Physics, one unit Chemistry, one unit Botany, one-half or one unit Zoölogy, one-half or one unit Physiology, one-half or one unit General Biology, one-half or one unit
GROUP V History and Social Sciences	Greek and Roman History, one unit Medieval and Modern History, one unit English History, one unit American History, one unit Economics, one-half or one unit Sociology, one-half unit Civics, one-half unit
GROUP VI Normal Training Subjects	Psychology, one-half unit Methods and Management, one-half unit Higher Arithmetic, one-half unit Reviews— Grammar, twelve weeks } Geography, twelve weeks } one unit Reading, twelve weeks } Music, one unit
GROUP VII Industrial Subjects	Agriculture, one-half or one, two, three, or four units Drawing, one-half or one unit Woodwork, one-half, one or two units Forging, one-half or one unit Domestic Science, one-half, one or two units Domestic Art, one-half, one or two units
GROUP VIII Commercial Subjects	Commercial Law, one-half unit Commercial Geography, one-half unit Bookkeeping, one-half or one unit Stenography and Typewriting, one-half or one unit

DEFICIENCIES

The courses in the School of Agriculture offered in connection with the College give every needed opportunity for students of the College to make up anything lacking in their preparation for entrance. All such entrance deficiencies must be made up before the beginning of the sophomore year. No student is registered in the senior class unless all deficiencies of the preceding years have been provided for. Candidates for graduation must make up all deficient subjects before the beginning of the spring term of the senior year. No student is considered a candidate for graduation the next June who is deficient more than three full subjects in addition to his regular assignment at the beginning of the fall term. No student who fails or is conditioned or found deficient in any subject, or whose grade in more than one subject falls below G in any term, is allowed to carry extra work during the succeeding term.

ADVANCED CREDIT

At the discretion of the President, students who present certificates showing credits for college work done in other institutions are allowed hour-for-hour credit on courses in this College in so far as they may be directly applied, or can be accepted as substitutions or electives. In cases in which it is impossible for one to furnish an acceptable certificate concerning work upon which advanced credit is asked, examinations are given, if the subject has been studied under competent instruction.

ADMISSION

ADMISSION BY EXAMINATION. Examinations for admission will be held at the College on Tuesday, September 15, 1914; Monday, January 4, 1915, for the winter term; and Monday, March 29, 1915, for the spring term.

ADMISSION BY CERTIFICATE. The applicant is required to submit to the Committee on Admission a certificate of the high-school or academy credit properly certified to by the authorities of the institution in which the work was done. Blanks will be furnished by the College for this purpose. It is requested that all work done in such high school or academy be presented upon these blanks, in order to expedite the granting of credit to such applicants as are entitled to it.

It is greatly to the advantage of the prospective student to see to it that this blank, properly filled out, be sent to the College as soon as possible after graduation. A permit to register will then be sent him by the Registrar in advance of his coming in September. This will greatly facilitate the work of entrance. The student will present this permit at the registration room in Nichols Gymnasium, and will not be compelled to wait his turn to meet the Committee on Admission.

General Information

DUTIES AND PRIVILEGES

Good conduct in general, such as becomes men and women everywhere, is expected of all students. Every possible aid and stimulus toward the development of sound and rational character, and toward the formation of high standards of personal honor and ideals of conduct, is given by the various Christian organizations of the College and the town. Every student is accordingly expected to render a good account of himself in the College community life. For those who are high-minded and reasonable, no other requirements need be expected. On the other hand, the demands of the College life leave no room for the idle or self-indulgent, for those who are too reckless to accept reasonable or wholesome restraint, or for those who are too careless or indifferent to take proper advantage of their opportunities. The College discipline is confined chiefly to sending away those whose conduct, after fair trial, makes their further attendance at the College unprofitable or inadvisable.

Absences from class or laboratory periods must be accounted for to the instructor concerned. Permission for absence from College for one or more days must be secured in advance from the dean of the division in which the student is registered. Students can not honorably leave the College before the close of a term except by previous arrangement with the deans concerned.

Opportunities for general scientific, literary, and forensic training are afforded, in addition to the College courses, by various literary and scientific societies and clubs. The Science Club, meeting monthly, admits to membership all instructors and students interested in science. The College branch of the American Institute of Electrical Engineers, the Agricultural Association, and the Architectural Club admit to their membership young men interested in the fields indicated by their names. Of the strictly literary and debating clubs, the Alpha Beta and the Franklin are open to both sexes; the Ionian, the Eurodelphian, and the Browning are women's societies; the Webster, the Hamilton, and the Athenian admit only young men to membership. In the School of Agriculture there are three literary societies, two for young men, the Lincoln and the Representative, and one for young women, the Philomathian.

At various times during the year, the College halls are opened for social, literary, musical, and dramatic entertainments furnished by lecture courses, by the literary societies, by the Department of Music, by the Dramatic Club, by the Oratorical Association, and by other organizations of students and instructors. Addresses by prominent speakers, men of affairs, and persons prominent in scientific, educational, and social work are of frequent occurrence.

EXPENSES

Tuition is free. An incidental fee of three dollars a term is charged all students resident in Kansas. For nonresidents, a matriculation, or entrance, fee of ten dollars, and an incidental fee of ten dollars a term, are charged. A medical fee of fifty cents a term is also collected from each student, in return for which he receives medical treatment in case of sickness. Class instruction in music is free; for individual instruction a fee is required. In all laboratories students are required to pay for apparatus broken or lost and for supplies. No other fees are charged. Rooms and board are not furnished by the College. Table board in private families and at boarding houses varies from $3.25 to $4.50 a week, the average being about $3.75. Rooms are obtainable at from $5 to $10 a month when occupied by one person, $8 to $12 when occupied by two. The highest-priced accommodations include light, heat, and bath.

The College Young Men's Christian Association offers accommodations in its building to a limited number of students, at prices from $10 to $13 a month for rooms with modern conveniences, and $3.25 a week for table board. As the number of rooms in the building is limited, applications should be made to the secretary of the association a year in advance. Board can usually be obtained at any time.

Some students board themselves at less cost than the prices charged for table board, and unfurnished rooms may sometimes be obtained very cheaply. Washing costs from 50 to 75 cents a dozen pieces. Books cost on the average about $5 a term.

Each young man who takes military drill is required to have a military uniform, costing about $15, and each young woman who takes physical training must have a physical-training suit, costing about $4. Ordinary expenditures, aside from clothing and traveling expenses, range from $175 to $300 a year.

SELF-SUPPORT

The courses of instruction are based upon the supposition that the student is here for study, and therefore a proper grasp of the subjects can not be obtained by the average student unless the greater part of his time is given to college work. Students of limited means are encouraged and aided in every possible way, but unless exceptionally strong, both mentally and physically, such students are advised to take lighter work by extending their courses, in case they are obliged to give any considerable time to self-support. As a rule, a student should be prepared with means for at least a term, as some time is required in which to make acquaintances and to learn where suitable work may be obtained.

There are various lines in which students may find employment. The College itself employs labor to the extent of about $1200 a month, at rates varying from 15 to 20 cents an hour, according to the nature of the employment and the experience of the employee. Most of this labor is upon the College farm, in the orchards and gardens, in the shops and the printing-office, for the janitor, etc. Various departments utilize student help to a considerable extent during the vacations. Students demonstrating exceptional efficiency, ability, and trustworthiness obtain limited employment in special duties about the College. Many students secure employment in various lines in the town, and some opportunity exists for obtaining board in exchange for work, with families either in town or in the neighboring country. Labor is universally respected in the College community, and the student who remains under the necessity of earning his way will find himself absolutely unhampered by discouraging social conditions. False standards regarding physical work do not exist, and are not tolerated by the board of instruction or by the student body as a whole. Absolutely democratic standards prevail at the College, and students are judged on the basis of their personal worth and efficiency alone.

Students are assisted to obtain employment by means of the employment bureaus maintained by the Young Men's Christian Association and by the Young Women's Christian Association of the College, with secretaries of which organizations correspondence is encouraged. New students are also met at the trains by committees from these two bodies, and are assisted in the finding of rooms, and in various other helpful ways.

BUSINESS DIRECTIONS

General information concerning the College may be obtained from the President or the Secretary. Financial matters are handled through the office of the Financial Secretary.

Scientific and practical questions, and requests for special advice along lines in which the College and the Experiment Stations are prepared to give information, should be addressed to the heads of the departments concerned with the work in which the information is sought.

Division of Mechanic Arts

ANDREY ABRAHAM POTTER, *Dean*

The Division of Mechanic Arts includes courses in agricultural engineering, architecture, civil and highway engineering, electrical engineering, and mechanical engineering, each leading to the degree of bachelor of science in the profession selected.

The work of the freshman year is the same in all courses; the work of the sophomore year is the same for students of mechanical engineering and electrical engineering, and, except that surveying is substituted for shop work, is the same for the course in civil engineering. For the course in architecture the plan of studies for the sophomore year is somewhat further modified.

While the courses offered are believed to be sufficient to cover the needs of the average young man, it is possible to combine portions of the work of two or more of these courses in such a way that one may be prepared to take up a special line of work for which he desires to fit himself. For example, by substituting certain subjects from the departments of chemistry and geology for some of those in the course in mechanical engineering, a young man can fit himself for work in connection with the manufacture of cement. By substituting some of the subjects in chemistry for others in mechanical engineering, a special preparation can be secured for chemical engineering. By combining some of the subjects of the courses in civil and mechanical engineering and by taking additional work in chemistry and geology, a young man may fit himself for special work in connection with the development of the coal fields throughout the country. By combining work in the courses in architecture and civil engineering, specialization in architectural engineering may be secured. In special cases permission will be granted to combine the work on the lines here indicated.

However, it is believed that the courses as tabulated give the best preparation for students expecting to follow general work in the profession selected, and for those who are not absolutely certain what branch of their profession they will follow. The substitutions and combinations indicated, and others similar to them, will be permitted only when there is good evidence that the student desiring such work is practically certain to follow the branch selected.

In the case of any of these modifications, the degree granted will be that of the course in which the major portion of the work is taken. In no case will the substitution of an additional amount of technical work for any of the general cultural work in the course be allowed.

COURSE IN AGRICULTURAL ENGINEERING

The course in agricultural engineering with its three options is designed to fit men as irrigation engineers, as designers of farm machinery and motors, or as flour-mill engineers and designers.

The work of the first year is the same as in the other engineering courses. During the second, third, and fourth years, students choosing the farm machinery option take considerable shop work, mechanics, kinematics, farm motors, farm machinery, hydraulics, and designing, besides such fundamental agricultural subjects as crops, soils, and farm management. In the irrigation and drainage engineering option the work of the second, third, and fourth years includes fundamental civil engineering subjects, such as surveying, civil engineering drawing, masonry and concrete design, structures. Considerable time is also devoted to problems in irrigation and drainage engineering, supplemented by courses in shop work, hydraulics, mechanics, crops, and soils. In the flour milling option considerable time is devoted to chemistry, flour-mill design, crops, grain inspection, wheat and flour testing, and milling practice. The student, in this option, is given the fundamental subjects in the mechanical-engineering course, including shop work, mechanical drawing, applied mechanics, hydraulics, and steam and gas engineering.

No student taking the course in agricultural engineering will be allowed to graduate who has not had at least six months' practical experience in the work of the option selected.

COURSE IN ARCHITECTURE

The course in architecture was organized to train men in the general field of architecture and also to relate the principles of architecture to farm buildings and grounds. The rapid increase in wealth in the State creates a demand for designers and builders of every type.

The freshman year of this course is identical with that of the other courses of the division of mechanic arts. The other three years are devoted to the study of pure and applied mathematics, mechanics, physics, history of architecture, municipal improvements, modern steel and cement construction, rural landscape architecture. The course aims to develop the creative powers of the student in the fields of original composition. From ten to sixteen hours a week, for the last three years of the course, are given to work of this kind over the drawing table.

The College is well equipped for the maintenance of a course in architecture. It owns a collection of several hundred plaster casts, tile and terra cotta samples, marble specimens, etc. It has a fine collection of models of the classic orders; a collection of blue-prints of residences, schoolhouses and churches, and of nearly all the Kansas state buildings; a large number of modern books on architecture and engineering; a complete set of the international edition of the *American Architect;* a complete set of the *Inland Architect,* and sets of several European architectural magazines; a well-equipped blue-print room, etc. The substantial stone buildings of the institution, their complete system of water-supply, drainage, heating and lighting, and one of the largest and handsomest campuses in America, furnish excellent illustrative material.

Students taking the course in architecture are expected to devote their summer vacations to practical work in actual building operations.

COURSE IN CIVIL AND HIGHWAY ENGINEERING

The aim of the course in civil engineering, with options in highway engineering, as outlined in the catalogue, is to give to the young men taking the course the best possible preparation for entering upon the active practice of the profession under present conditions. It will be noted that the first and second years of the course are devoted almost entirely to general culture studies and the sciences, including mathematics. This follows the arrangement generally found in the engineering courses of American colleges, and it finds its justification in the well-nigh universally accepted idea that any engineering education worthy of consideration must be grounded upon ample preliminary education in the allied sciences. In recognition of the mechanical trend of the age, liberal provision is made in the course for class and laboratory work in mechanical and electrical engineering.

In view of the growing importance of municipal problems, such as paving, sewerage and water-supply, the course in civil engineering includes a required course in municipal engineering, supplemented by courses in sanitary biology and chemistry.

The work in highway engineering affords time for an unusually thorough course in this subject, which is of such great importance at the present time. It includes courses in road machinery, and road building.

A liberal course in drainage and irrigation engineering is introduced for those who may wish to take up this line of work, which is coming rapidly into prominence.

COURSE IN ELECTRICAL ENGINEERING

The essential elements underlying a sound engineering training are based upon a thorough study of mathematics and the physical sciences. The professional work of this course begins in the third year and continues throughout the rest of the course. General culture subjects are offered during the first three years of the course.

Emphasis is placed upon training to deal with forces and matter according to scientific principles, rather than upon the accumulation of facts. The department laboratories are well equipped with the various measuring instruments, standardizing apparatus, and the different types of dynamo machinery. The different subjects are presented in the classroom, and the classroom work is supplemented by laboratory practice. The course provides a liberal training in wood- and iron-working, mechanical drawing, and machine-shop pracice. The laboratory experiments selected for the student are designed to give a clear conception of the theoretical work of the classroom.

Students are given extensive practice in connecting up the different types of machines for testing purposes and for standard commercial work. This practice work and testing extends throughout the junior and senior years, and is intended to give the student familiarity with the underlying principles of the different machines, and a knowledge of the care necessary to operate them successfully. Opportunity is also given to undertake the investigation of commercial problems as they are sent to the College from the different central stations of the State.

In connection with the regular work of the classroom and the laboratory, extensive references are given to leading books and to current literature on technical engineering. In connection with the laboratory work a certain amount of library work is required. In the year 1908 a College branch of the American Institute of Electrical Engineers was organized. The branch meets the first Tuesday of each month. At these meetings the instructors meet with the students for the discussion of technical subjects in engineering. Consulting engineers and central-station managers are invited to present papers at these meetings.

COURSE IN MECHANICAL ENGINEERING

The course in mechanical engineering prepares for the successful management and superintendence of factories and power plants; for the design of power and machinery installations; for the design and construction of machine tools, steam and gas engines, compressors, hydraulic machinery, etc.; and for the design and erection of mill and engineering buildings.

The course of study has been laid out with the aim of securing a judicious mixture of theory and practice, such as will not only give the student the technical skill required for engineering operations, but will also give him a broad grasp of the fundamental principles of his profession.

It is not the intention in this course to give the young man training similar to that received in serving an apprenticeship, but rather to instruct him in the technical and theoretical principles upon which the art of mechanical engineering is based, without a thorough knowledge of which a man can not rise to a position of responsibility in this profession. The advantages of combining a practical application of principles with theoretical instruction, while these principles are being impressed upon the student by classroom work, are well known.

The course in shop work, being purely educational in its character, is designed to teach the various methods of doing shop work, the operations that may be performed upon the different machines, and upon what machines certain operations can be performed most economically, as well as to acquaint the student with what may be expected not only from the machines, but from the men operating them. In order to secure this knowledge it is necessary that the student should perform a large variety of operations. To accomplish this result, an appreciable proportion of the course consists of graded exercises. Wherever possible the student also is assigned to work on apparatus and machinery that is being built for use in the engineering or other departments of the College, a large amount of which is constantly under way in the shops.

Each student in the course in mechanical engineering is required to present before graduation a satisfactory thesis that shows the results of original research along engineering lines.

Course in Agricultural Engineering

Option 1—Farm Machinery
Option 2—Irrigation and Drainage Engineering
Option 3—Flour Milling

The Arabic numeral immediately following the name of a subject indicates the number of credits, while the numerals in parentheses indicate the number of hours a week of recitation and of laboratory, respectively.

FRESHMAN

FALL	WINTER	SPRING
English I 4 (4-0)	English II 4 (4-0)	English Literature 4 (4-0)
	Library Methods E 1 (0-2)	
Chemistry I 4 (3-2)	Chemistry II 4 (2-4)	Chemistry III 4 (3-2)
Plane Trigonometry 4 (4-0)	College Algebra 4 (4-0)	Analytical Geometry 4 (4-0)
Descriptive Geometry I 3 (2-2)	Descriptive Geometry II 3 (2-2)	Descriptive Geometry III 3 (2-2)
Blacksmithing I 3 (1-4)	Blacksmithing II 2 (0-4)	Foundry 3 (1-4)
Military Drill	Military Drill	Military Drill

AGRICULTURAL ENGINEERING—*continued*

SOPHOMORE

FALL	WINTER	SPRING
Engineering Physics I 5 (4-2)	Engineering Physics II 5 (4-2)	Engineering Physics III 6 (4-4)
Calculus I 4 (4-0)	Calculus II 4 (4-0)	Calculus III 4 (4-0)
Mechanical Drawing I 2 (1-2)	Mechanical Drawing II 3 (1-4)	Machine Shop 2 (0-4)
	Extempore Speech 2 (2-0)	
Military Drill	Military Drill	Military Drill
Option I	*Options I and II*	*Option I*
Pattern Making 3 (1-4)	Industrial History 4 (4-0)	Surveying 3 (1-4)
Kinematics I 4 (4-0)		Mechanical Drawing III 3 (0-6)
Option II		*Option II*
Surveying I 7 (4-6)		General Bacteriology 4 (2-4)
		Agricultural Chemistry 2 (2-0)
Option III	*Option III*	*Option III*
Pattern Making 3 (1-4)	Kinematics I 4 (4-0)	Quantitative Analysis I 3 (0-6)
Qualitative Analysis 4 (2-4)		Mechanical Drawing III 3 (0-6)

JUNIOR

Applied Mechanics I 5 (4-2)	Applied Mechanics II 5 (4-2)	Hydraulics 4 (3-2)
Cereal Crop Production 5 (3-4)		Economics 4 (4-0)
Machine Shop II 2 (0-4)		
Options I and II	*Options I and II*	*Option I*
General Geology 4 (4-0)	Farm Motors I 4 (2-4)	Farm Motors II 3 (2-2)
Elective 2 (-)	Soils I 5 (3-4)	Farm Machinery 4 (2-4)
	Option I	Elective 3 (-)
	Machine Shop III-A 4 (1-6)	
	Option II	*Option II*
	Graphic Statics 2 (0-4)	Farm Motors II 3 (2-2)
	C. E. Drawing I 2 (0-4)	Farm Machinery 4 (2-4)
		Foundations 3 (3-0)
Option III	*Option III*	*Option III*
Quantitative Analysis II 2 (0-4)	Quantitative Analysis III 2 (0-4)	Electrical Engineering C 4 (3-2)
Commercial Grain and Grain Inspection 4 (3-2)	Advanced Industrial History 4 (4-0)	Machine Shop IV 4 (1-6)
	Grain Products 4 (3-2)	Experimental Milling 2 (0-4)
	Machine Shop III 3 (1-4)	

AGRICULTURAL ENGINEERING—*continued*

SENIOR

FALL	WINTER	SPRING
Options I and II	*Options I and II*	*Options I and II*
Hydraulic Machinery 3 (2-2)	Farm Management 4 (3-2)	Electrical Engineering C 4 (3-2)
		Business Organization 2 (2-0)
		Highway Engineering 3 (3-0)
		Concrete Construction 3 (1-4)
		Business Law 2 (2-0)
Option I	*Option I*	*Option I*
Farm Machinery II 3 (0-6)	Farm Buildings and Equip. 5 (2-6)	Factory Design 3 (0-6)
Traction Engines 3 (1-4)	Factory Engineering 2 (2-0)	Thesis
Machine Design I 3 (1-4)	Machine Design II-A 2 (1-2)	
Electives 6 (-)	Electives 5 (-)	
Thesis	Thesis	
Option II	*Option II*	*Option II*
Drainage and Irrigation I 3 (3-0)	Drainage and Irrigation II 3 (1-4)	Drainage and Irrigation III 3 (0-6)
Surveying II 7 (4-6)	Structures 6 (3-6)	Thesis
Electives 4 (4-0)	Masonry and Concrete 5 (3-4)	
Thesis	Thesis	
Option III	*Option III*	*Option III*
Flour Mill Design I 5 (2-6)	Flour Mill Design II 3 (0-6)	Heating and Ventilation 3 (2-2)
Steam and Gas Engr. E-I 5 (4-2)	Steam and Gas Engr. E-II 5 (4-2)	Milling Entomology 2 (2-0)
Advanced Exper. Milling 4 (0-8)	Wheat and Flour Testing 4 (1-6)	Experimental Baking Tests 4 (0-8)
General Entomology 4 (3-2)	Factory Engineering 2 (2-0)	Milling Practice 4 (0-8)
	Business Organization 2 (2-0)	Factory Design 3 (0-6)
	Business Law 2 (2-0)	Thesis
Thesis	Thesis	

Course in Architecture

The Arabic numeral immediately following the name of a subject indicates the number of credits, while the numerals in parentheses indicate the number of hours a week of recitation and of laboratory, respectively.

FRESHMAN

FALL	WINTER	SPRING
English I 4 (4-0)	English II 4 (4-0)	English Literature 4 (4-0)
	Library Methods E 1 (0-2)	
Chemistry I 4 (3-2)	Chemistry II 4 (2-4)	Chemistry III 4 (3-2)
Plane Trigonometry 4 (4-0)	College Algebra 4 (4-0)	Analytical Geometry 4 (4-0)
Descriptive Geometry I 3 (2-2)	Descriptive Geometry II 3 (2-2)	Descriptive Geometry III 3 (2-2)
Blacksmithing I 3 (1-4)	Blacksmithing II 2 (0-4)	Foundry 3 (1-4)
Military Drill	Military Drill	Military Drill

ARCHITECTURE—*continued*

SOPHOMORE

FALL	WINTER	SPRING
Engineering Physics I 5 (4-2)	Engineering Physics II 5 (4-2)	Engineering Physics III 6 (4-4)
Advanced Industrial History 4 (4-0)	General Bacteriology 4 (2-4)	Extempore Speech 2 (2-0)
Residences 4 (4-0)	Historic Ornament 4 (4-0)	Kinematics I 4 (4-0)
Shades and Shadows 2 (0-4)	Linear Perspective 2 (0-4)	Surveying 3 (1-4)
Architectural Drawing I 3 (0-6)	Architectural Drawing II 3 (0-6)	Architectural Drawing III 3 (0-6)
Military Drill	Military Drill	Military Drill

JUNIOR

History of Architecture I 4 (4-0)	History of Architecture II 4 (4-0)	History of Architecture III 4 (4-0)
Economics 4 (4-0)	Business Law 2 (2-0)	Engineering Geology 6 (4-4)
Acoustics 1 (1-0)	Business Organization 2 (2-0)	Graphic Statics 2 (0-4)
Advanced Woodwork 3 (1-4)	Heating 4 (4-0)	Mural Decoration 3 (0-6)
Clay Modeling 3 (0-6)	Color and Design A 3 (0-6)	
Architectural Composition I 3 (0-6)	Architectural Composition II 3 (0-6)	Architect'l Composition III 3 (0-6)

SENIOR

Public Buildings 4 (4-0)	Specifications 4 (4-0)	Landscape Architecture 4 (4-0)
Plumbing 2 (2-0)	Trusses 4 (2-4)	Power and Lighting 4 (3-2)
Beams and Arches 3 (1-4)	Architectural Seminar 4 (4-0)	Landscape Design 4 (0-8)
Municipal Improvements 4 (4-0)	Color Rendering 2 (0-4)	
Ink Rendering 2 (0-4)		
Architect'l Composition IV 3 (0-6)	Architectural Composition V	Architectural Thesis 6 (0-12)

Course in Civil and Highway Engineering

The Arabic numeral immediately following the name of a subject indicates the number of credits, while the numerals in parentheses indicate the number of hours a week of recitation and of laboratory, respectively.

FRESHMAN

FALL	WINTER	SPRING
English I 4 (4-0)	English II 4 (4-0)	English Literature 4 (4-0)
Chemistry I 4 (3-2)	Chemistry II 4 (2-4)	Chemistry III 4 (3-2)
Plane Trigonometry 4 (4-0)	College Algebra 4 (4-0)	Analytical Geometry 4 (4-0)
Descriptive Geometry I 3 (2-2)	Descriptive Geometry II 3 (2-2)	Descriptive Geometry III 3 (2-2)
	Library Methods E 1 (0-2)	
Blacksmithing I 3 (1-4)	Blacksmithing II 2 (0-4)	Foundry 3 (1-4)
Military Drill	Military Drill	Military Drill

CIVIL AND HIGHWAY ENGINEERING—*continued*

SOPHOMORE

FALL	WINTER	SPRING
Calculus I 4 (4-0)	Calculus II 4 (4-0)	Calculus III 4 (4-0)
Engineering Physics I 5 (4-2)	Engineering Physics II 5 (4-2)	Engineering Physics III 6 (4-4)
Mechanical Drawing I 2 (1-2)	General Bacteriology 4 (2-4)	Mechanical Drawing II 3 (1-4)
Surveying I 7 (4-6)	Military Drill	Extempore Speech 2 (2-0)
Military Drill	*Option I*	Foundations 3 (3-0)
	Chemistry C 5 (1-8)	Military Drill
	Option II	
	Soils 5 (1-8)	

JUNIOR

FALL	WINTER	SPRING
Economics 4 (4-0)	Business Law 2 (2-0)	Engineering Geology 6 (4-4)
Surveying II 7 (4-6)	Business Organization 2 (2-0)	Hydraulics 4 (3-2)
Applied Mechanics I 5 (4-2)	Applied Mechanics II CE 6 (4-4)	Applied Mechanics III 4 (3-2)
Option I	Advanced Industrial History 4 (4-0)	
Spherical Trigonometry 2 (2-0)	Graphic Statics 2 (0-4)	C. E. Drawing II 4 (0-8)
Option II	C. E. Drawing I 2 (0-4)	
Road Machinery Laboratory 2 (2-0)		

SENIOR

FALL	WINTER	SPRING
Bridge Stresses 4 (4-0)	Bridge Design 6 (3-6)	Electrical Engineering CE 4 (3-2)
		Option I
Steam and Gas Engr. C 4 (3-2)	Railways I 3 (3-0)	Railways II 4 (0-8)
Drainage and Irrigation I 3 (3-0)	Masonry and Concrete 5 (3-4)	Geodesy 4 (2-4)
Option I	*Option I*	Highway Engineering 3 (3-0)
Water Supply and Sewerage 4 (4-0)	Astronomy 3 (2-2)	
Hydraulic Machinery 3 (2-2)		
Thesis	Thesis	Thesis
Option II	*Option II*	*Option II*
Highway Engineering I 7 (4-6)	Highway Engineering II 4 (4-0)	Concrete Construction 2 (0-4)
		Specification and Inspection 2 (2-0)
		Highway Engineering III 7 (3-8)
Thesis	Thesis	Thesis

Course in Electrical Engineering

The Arabic numeral immediately following the name of a subject indicates the number of credits, while the numerals in parentheses indicate the number of hours a week of recitation and of laboratory, respectively.

FRESHMAN

FALL	WINTER	SPRING
English I 4 (4-0)	English II 4 (4-0)	English Literature 4 (4-0)
Chemistry I 4 (3-2)	Chemistry II 4 (2-4)	Chemistry III 4 (3-2)
Plane Trigonometry 4 (4-0)	College Algebra 4 (4-0)	Analytical Geometry 4 (4-0)
Descriptive Geometry I 3 (2-2)	Descriptive Geometry II 3 (2-2)	Descriptive Geometry III 3 (2-2)
	Library Methods E 1 (0-2)	
Blacksmithing I 3 (1-4)	Blacksmithing II 2 (0-4)	Foundry 3 (1-4)
Military Drill	Military Drill	Military Drill

SOPHOMORE

Advanced Industrial History 4 (4-0)	Kinematics 4 (4-0)	Surveying 3 (1-4)
Engineering Physics I 5 (4-2)	Engineering Physics II 5 (4-2)	Engineering Physics III 6 (4-4)
Calculus I 4 (4-0)	Calculus II 4 (4-0)	Calculus III 4 (4-0)
Mechanical Drawing I 2 (1-2)	Mechanical Drawing II 3 (1-4)	Mechanical Drawing III 3 (0-6)
Pattern Making 3 (1-4)	Machine Shop I 2 (0-4)	Machine Shop II 2 (0-4)
Military Drill	Military Drill	Military Drill

JUNIOR

Economics 4 (4-0)	Extempore Speech 2 (2-0)	Business Law 2 (2-0)
Seminar E I 1 (1-0)		Business Organization 2 (2-0)
Applied Mechanics I 5 (4-2)	Applied Mechanics II CE 6 (4-4)	Hydraulics 4 (3-2)
Theory of Electricity I 5 (4-2)	Theory of Electricity II 4 (3-2)	Electrical Instruments and Calibration 4 (2-4)
Machine Shop III 3 (1-4)	D. C. Machines I 6 (4-4)	D. C. Machines II 6 (4-4)

SENIOR

D. C. Machine Design 4 (2-4)	Seminar E II 2 (2-0)	Generation and Distribution of Elec. Energy 4 (4-0)
Steam and Gas Engr. E I 5 (4-2)	Steam and Gas Engr. E II 5 (4-2)	Refrigeration 3 (2-2)
A. C. Machines I 6 (4-4)	A. C. Machines II 6 (4-4)	A. C. Machine Design 2 (1-2)
		Power-plant Design and Specifications 4 (1-6)
Hydraulic Machinery 3 (2-2)	Telephone Engineering 4 (3-2)	Illuminating Engineering 3 (2-2)
Thesis	Thesis	Thesis

Course in Mechanical Engineering

The Arabic numeral immediately following the name of a subject indicates the number of credits, while the numerals in parentheses indicate the number of hours a week of recitation and of laboratory, respectively.

FRESHMAN

FALL	WINTER	SPRING
English I 4 (4-0)	English II 4 (4-0)	English Literature 4 (4-0)
	Library Methods E 1 (0-2)	
Chemistry I 4 (3-2)	Chemistry II 4 (2-4)	Chemistry III 4 (3-2)
Plane Trigonometry 4 (4-0)	College Algebra 4 (4-0)	Analytical Geometry 4 (4-0)
Descriptive Geometry I 3 (2-2)	Descriptive Geometry II 3 (2-2)	Descriptive Geometry III 3 (2-2)
Blacksmithing I 3 (1-4)	Blacksmithing II 2 (0-4)	Foundry 3 (1-4)
Military Drill	Military Drill	Military Drill

SOPHOMORE

Advanced Industrial History 4 (4-0)	Kinematics 4 (4-0)	Surveying 3 (1-4)
Engineering Physics I 5 (4-2)	Engineering Physics II 5 (4-2)	Engineering Physics III 6 (4-4)
Calculus I 4 (4-0)	Calculus II 4 (4-0)	Calculus III 4 (4-0)
Mechanical Drawing I 2 (1-2)	Mechanical Drawing II 3 (1-4)	Mechanical Drawing III 3 (0-6)
Pattern Making 3 (1-4)	Extempore Speech 2 (2-0)	Machine Shop I 2 (0-4)
Military Drill	Military Drill	Military Drill

JUNIOR

Economics 4 (4-0)	Business Law 2 (2-0)	Hydraulics 4 (3-2)
	Business Organization 2 (2-0)	Graphic Statics 2 (0-4)
Applied Mechanics I 5 (4-2)	Applied Mechanics II M 5 (4-2)	Applied Mechanics III 4 (3-2)
Steam and Gas Engineer'g I 4 (4-0)	Steam and Gas Engr. II 4 (3-2)	Steam and Gas Engr. III 4 (3-2)
Kinematics II 3 (2-2)	Mechanical Drawing IV 2 (0-4)	
Machine Shop II 2 (0-4)	Machine Shop III 3 (1-4)	Machine Shop IV 4 (1-6)

SENIOR

Applied Mechanics IV 3 (2-2)	Factory Engineering 2 (2-0)	Factory Design 3 (0-6)
	Power Plant Engineering 2 (2-0)	Power Plant Design 2 (0-4)
Steam and Gas Engr. IV 4 (3-2)	Steam and Gas Engr. V 4 (3-2)	Refrigeration 3 (2-2)
Electrical Engineering M I 5 (4-2)	Electrical Engineering M II 5 (4-2)	Heating and Ventilation 3 (2-2)
Machine Design I 3 (1-4)	Machine Design II 2 (0-4)	Machine Design III 3 (0-6)
Hydraulic Machinery 3 (2-2)	Machine Shop V 2 (0-4)	Machine Shop VI 2 (0-4)
Thesis	Thesis	Thesis

Applied Mechanics and Machine Design

Professor Seaton
Instructor Bowerman
Instructor Freeman
Instructor McNair

The courses in applied mechanics are designed primarily to teach the graphical and analytical methods of determination, both of the forces acting on the parts of structures and machines, and of the effect of these forces on the parts, together with the fundamental principles of the design of the parts to meet specified conditions. The course is intended to be of a highly practical character. For the purpose of better fixing in the mind of the student the principles taught, the solution of a large number of problems involving these principles is required in both the applied mechanics and hydraulics. The principles are further illustrated by means of the laboratory and drafting-room work, which parallels the classroom instruction. The textbooks in several of the courses are supplemented by notes and assigned reference work.

APPLIED MECHANICS LABORATORY

For testing the strength of materials this laboratory is provided with a 100,000-pound Riehle Universal Testing Machine, a 200,000-pound Olsen Universal Testing Machine adapted for receiving columns up to 15 feet in length, a 250,000-inch-pound Torsion Testing Machine, a 10,000-pound beam testing machine and the auxiliary apparatus usually found in such laboratories.

This laboratory also contains transmission and absorption dynamometers, an oil and bearing testing machine, screws, jacks, hoists, scales, gauges and other small instruments for taking weights and measurements. There is a full equipment of apparatus for making standard cement and concrete tests, a concrete building block machine and molds for various concrete products, such as drainage tile and fence posts.

The road materials laboratory contains an Olsen standard rattler for testing paving brick, a ball mill briquette former, impact machines, abrasion machine, hardness testing machine, diamond saw, core drill, and the usual auxiliary apparatus, as scales, ovens, etc.

HYDRAULICS LABORATORY

The hydraulics laboratory contains two hydraulic pits of 25,000 gallons capacity each, an air-pressure tank, two hydraulic rams, two 4-inch volute centrifugal pumps, one 18-inch deep-well four-stage centrifugal pump, one positive rotary pump, two deep-well reciprocating pumps, a water motor, a Pelton-Doble water wheel, a small Price current meter, a Haskell current meter, and many pieces of small apparatus, such as weirs, scales, tanks, hook gauges, pressure gauges, and manometers.

All laboratory tests of a commercial character are conducted in accordance with the standard methods prescribed by the national societies. Complete reports are required of the students on all laboratory exercises.

COURSES IN APPLIED MECHANICS AND MACHINE DESIGN

1.—APPLIED MECHANICS I. Junior year, fall term. Class work, four hours; laboratory, two hours. Five credits. Prerequisites: Calculus III; Engineering Physics III.

This course includes composition, resolution and conditions of equilibrium of concurrent and nonconcurrent forces; center of gravity; laws of rectilinear and curvilinear motion of material points; moments of inertia; relations between forces acting on rigid bodies and the resulting motions; work energy and power; graphical solutions of problems in statics. Text, Hancock's *Applied Mechanics for Engineers.*

2.—APPLIED MECHANICS II. Junior year, winter term. Class work, four hours; laboratory, two or four hours. Five or six credits. Prerequisite: Applied Mechanics I.

This course treats of the following: behavior of materials subjected to tension, compression, and shear; riveted joints; torsion; shafts, and the transmission of power; strength and stiffness of beams and cantilevers; bending moments and shear forces in beams; design of beams of wood, cast iron, steel, and reinforced concrete; design of built-up beams and box girders; resilience of beams; stresses in columns and hooks; and the design of columns of wood, cast iron, steel, and concrete. Text, Boyd's *Strength of Materials. Cambria Steel* is used for reference.

3.—GRAPHIC STATICS. Junior year, winter and spring terms. Drafting-room practice, supplemented by lectures, four hours. Two credits. Prerequisite: Applied Mechanics II; or the two courses may be taken together.

The graphical solution of stresses existing in a number of typical trusses, with a detail design of one of the simpler forms of roof trusses is the subject matter of the course.

4.—APPLIED MECHANICS III. Junior year, spring term. Class work, three hours; laboratory, two hours. Four credits. Prerequisite: Applied Mechanics II.

This course treats of stresses in continuous and built-up beams; masonry arches, and arch ribs; stability of dams and retaining walls; properties of materials for reinforced concrete; mechanical bond; rectangular and T beams; double reinforced beams; web reinforcing; columns reinforced with bars and hoops; reinforced concrete in building construction; design of slabs, beams, girders, and columns. Texts, *Boyd's Strength of Materials*, and Turneaure and Maurer's *Principles of Reinforced Concrete Construction.*

5.—HYDRAULICS. Junior year, spring term. Class work, three hours; laboratory, two hours. Four credits. Prerequisite: Applied Mechanics I.

This course includes a study of fluid pressure, stresses in containing vessels and pipes, center of pressure, immersion and flotation; of Bernoulli's theorem, with applications; of flow through orifices, weirs, short and long pipes; of loss of head due to various causes; of flow of water in open channels, and its measurement; of Kutter's formula; of impulse and reaction of a jet; of power of jets; of plates moving in fluids. Text, Russel's *Textbook on Hydraulics.*

6.—APPLIED MECHANICS IV. Senior year, fall term. Class work, three hours. Three credits. Prerequisite: Applied Mechanics III.

Dynamics of machinery, friction, lubrication and lubricants, are studied in this course. Text, Lanza's *Dynamics of Machines.*

7.—HYDRAULIC MACHINERY. Senior year, fall term. Class work, two hours; laboratory, two hours. Three credits. Prerequisite: Hydraulics.

This course treats of elements of water power; design, construction and operation of gravity motors, impulse wheels and turbines; regulation of water motors; testing of impulse wheels and turbines; centrifugal, turbine and reciprocating pumps; pressure engines, accumulators, and hydraulic rams. Text, Church's *Hydraulic Motors.*

COURSES IN APPLIED MECHANICS LABORATORY

Text: Carpenter and Diederich's *Experimental Engineering.*

1.—APPLIED MECHANICS I LABORATORY. Junior year, fall term. Two hours a week. One credit. Applied Mechanics I must accompany or precede this course.

This course consists of the calibration and use of laboratory measuring instruments and apparatus, and tests of cements and concrete aggregates.

2.—APPLIED MECHANICS II-CE (AND II-M). Junior year, winter term. Four hours, two credits; and two hours, one credit, respectively.

This course covers tensile, compressive, and transverse tests of wood, metals, and concrete, mixing and handling concrete, and for civil engineering students are tests of road-making and paving materials.

3.—APPLIED MECHANICS III LABORATORY. Junior year, spring term. Five hours per week. One credit. Prerequisite: Applied Mechanics II Laboratory.

This is a continuation of the work of the preceding term, with tests of full-size columns and beams, use of the strain gauge in determining the elastic stresses in structures, torsion tests of metals, tests of building brick and stone, and the manufacture of cast concrete specimens.

4.—HYDRAULIC LABORATORY. Junior year, spring term. Two hours a week. One credit.

This course includes tests to determine the coefficients of weirs, orifices, tubes, and pipes; use and calibration of water meters; tests to determine loss of head in pipes due to various causes, and the measurement of water in open streams. Prerequisite: Applied Mechanics I Laboratory. Hydraulics must accompany or precede this course.

5.—APPLIED MECHANICS IV LABORATORY. Senior year, fall term. Two hours a week. One credit. Taken in connection with Applied Mechanics IV.

This course includes tests of bearings and lubricants; impact tests, measurements of power in transmission, and of slippage of belts. About half the time of the course is spent in the drafting-room in the determination of the cyclic energy distribution at the crank shaft of a steam engine, and the design of flywheels for a stated degree of speed regulation. Prerequisite: Applied Mechanics III. Applied Mechanics IV must accompany or precede this course.

6.—HYDRAULIC MACHINERY LABORATORY. Senior year, fall term. Two hours a week. One credit. Taken in connection with Hydraulic Machinery. Prerequisite: Hydraulic Laboratory. Hydraulic Machinery must accompany or precede this course.

The course includes tests on water wheels, water motors, rams, and pumps.

COURSES IN MECHANICAL DRAWING AND MACHINE DESIGN

1.—MECHANICAL DRAWING I. Sophomore year, fall term. Lectures and recitations, one hour; drafting-room practice, two hours. Two credits. Prerequisite: Descriptive Geometry II.

The course includes the use and care of drawing instruments, with simple exercises in making working drawings from given plates. Special attention is given to the arrangement of views to secure balance, and to the subject matter and layout of titles and notes. The following supplies are required: triangles, T-square, scale, pencils, pens, ink, erasers, thumb tacks, drawing paper, and a set of drawing instruments. Students are advised not to purchase these supplies until after consulting with the instructor. Text, French's *Engineering Drawing.*

2.—MECHANICAL DRAWING II. Sophomore year, winter term. Lectures and recitation, one hour; drafting-room practice, four hours. Three credits. Prerequisites: Mechanical Drawing I; Descriptive Geometry III.

Free-hand sketches are made from simple machine parts, followed by complete working drawings from these sketches without further reference to the objects. Special emphasis is laid upon the proper selection of views to present the necessary information in convenient form, and to give the proper dimensioning of the drawings. Text, French's *Engineering Drawing.*

3.—KINEMATICS I. Sophomore year, spring term. Lectures and recitations, four hours. Four credits. Prerequisites: Plane Trigonometry; Descriptive Geometry II.

An analysis of the motions and forms of the parts of machines constitutes this course. Among the subjects discussed are: bearings, screws, worm and wheel, rolling cylinders, cones, and other surfaces; belts, cords and chains, levers, cams and linkwork, with the velocity and motion diagrams; quick returns, straight-line motions, and other special forms of linkages; conjugate curves for gear teeth, cycloidal and involute systems of gearing, spur, annular and bevel gears, and special forms of gearing. The solution of a large number of graphical and mathematical problems is required in this course. Text, Schwamb and Merrill's *Elements of Mechanism.*

4.—MECHANICAL DRAWING III. Sophomore year, spring term. Drafting-room practice, six hours. Three credits. Prerequisite: Mechanical Drawing II. Kinematics I must accompany or precede this course.

The work in the first part of the term is a continuation of that given in Mechanical Drawing II. This is followed by the design of cams, gears, and quick returns to fulfill specified conditions. Center-line drawings are first made, embodying the solution of the problems, and upon these are built working drawings of machine parts. An effort is made to follow standard practice in the design of those details usually determined by empirical methods. Velocity diagrams are drawn for the cams and quick returns. Gear teeth are accurately rolled and drawn from templates prepared by the student.

5.—KINEMATICS II. Junior year, fall term. Lectures and recitations, two hours; drafting-room practice, two hours. Three credits. Prerequisites: Kinematics I; Mechanical Drawing III.

This course is a continuation of Kinematics I, consisting of a consideration of the following subjects: mechanisms for producing intermittent motion, such as clicks, ratchets, and escapements; wheels in trains; and combinations of mechanisms. The drafting-room practice is a continuation of the work given in Mechanical Drawing III, and consists of the application of the classroom instruction to some simple problems in the design of mechanisms. Text, Schwamb and Merrill's *Elements of Mechanism.*

6.—MECHANICAL DRAWING IV. Junior year, winter term. Drafting-room practice, four hours. Two credits. Prerequisite: Steam Engineering I. Applied Mechanics II must accompany or precede this course.

This includes the solution of a problem on the slide valve by the Zeuner diagram, followed by the design, mostly by empirical methods, of the cylinder, piston, steam chest, and valve of a steam engine. Kent's *Mechanical Engineer's Pocketbook* is extensively used for reference, and each student is expected to have a copy.

7.—MACHINE DESIGN I. Senior year, fall term. Lecture and recitation, one hour; drafting-room practice, four hours. Three credits. Prerequisites: Mechanical Drawing III; Applied Mechanics II; and Steam Engineering II or Farm Motors II.

This course includes a careful study of the fundamentals of machine design. The energy and force problems and the straining action in machine elements are considered, together with the design of these elements to meet specified conditions as to strength and rigidity.

The drafting-room practice consists of the solution of several problems in design based on the principles already learned in Applied Mechanics. In the latter part of the term work is begun on the design of a steam boiler. Calculations are made to determine the dimensions of all parts, and working drawings are made. Text, Kimball and Barr's *Elements of Machine Design.*

8.—MACHINE DESIGN II AND II-A. Senior year, winter term. Drafting-room practice, four hours. Two credits. Prerequisite: Machine Design I.

This is a continuation of the work of the fall term. The design of the steam boiler is completed, and work is begun on the design of a power shear by the mechanical-engineering students, while the agricultural engineering students devote the remainder of the term to the design of farm machinery.

9.—MACHINE DESIGN III. Senior year, spring term. Drafting-room practice, six hours. Three credits. Prerequisite: Machine Design II.

This is a continuation of the work of the winter term, covering the completion of the design of the power shear.

10.—FLOUR MILL DESIGN I. Senior year, fall term. Lectures, two hours; drafting-room practice, six hours. Five credits. Prerequisites: Mechanical Drawing III, and Applied Mechanics II. Advanced Experimental Milling I must accompany or precede this course.

Lectures are given on the fundamental principles of the design and selection of machinery for flour mills. Drafting-room practice is had in the design of machines and in planning the arrangement of machines in flour mills.

11.—FLOUR MILL DESIGN II. Senior year, winter term. Drafting-room practice, six hours. Three credits.

This is a continuation of the work of the preceding term and includes the layout of flow sheets, and the diagramming of mills.

Architecture and Drawing

Professor WALTERS
Assistant Professor ———
Instructor HARRIS
Instructor COITH-NELSON
Assistant HOLMAN
Assistant AVERILL
Assistant SMITH

The educational and practical value of a systematic course in the various branches of drawing can hardly be overestimated. The general aims of the several courses in industrial art are the same: (*a*) the cultivation of observation and analysis of form; (*b*) the development of correct taste; (*c*) the teaching of the different methods of graphic representation; (*d*) the acquirement of skill in handling drawing tools.

The instruction offered in architecture is intended to supply the preliminary training required for the practice of architecture. It recognizes the fact that this instruction must have a three-fold object: first, the teaching of sound modern building construction; second, the teaching of different methods of graphic representation; and third, the development of correct taste.

The first is attained, in connection with the work in other departments, by lectures, and by extended laboratory work in heating, plumbing, concrete construction, steel construction, and electric lighting, also by the preparation of building specifications and by investigations of the legal and ethical relations of architect, owner, and contractor. The second end involves the teaching of correct perception and analysis of form. An average of twelve hours a week throughout the four years is given to projection drawing, descriptive geometry, isometric drawing, linear perspective, shades and shadows, sketching from casts and from life, architectural drawing, and architectural composition. The development of correct taste is sought by offering much work in sketching and rendering, mural decoration, landscape architecture, architectural criticism, and architectural composition. Five terms are devoted to the study of the fundamental principles of design and the styles of the past. Considerable emphasis is also laid on the problems of architecture as related to the needs of rural communities.

COURSES IN ARCHITECTURE AND DRAWING

1.—FREE-HAND DRAWING. Freshman year, winter or spring term. Drafting-room practice, four hours. Two credits.

Exercises are given in drawing simple figures and ornaments illustrating the effects of geometric arrangement, radiation, repetition, symmetry, proportion, harmony, and contrast; in drawing conventional plant ornaments; in free-hand lettering.

2.—OBJECT DRAWING. Freshman year, fall or spring term. Drafting-room practice, four hours. Two credits.

The course comprises drawing from models and simple objects, and exercises in shading from the object and from imagination.

3.—GEOMETRICAL DRAWING. Freshman or sophomore year, winter term. Drafting-room practice, four hours. Two credits.

In this course are taught construction of perpendiculars, parallels, angles, polygons, tangent connections, etc.; construction of the ovoid, the oval, the ellipse, and the spiral; the use of the T-square, triangles, the drawing-board, and India ink; lettering.

4.—DESCRIPTIVE GEOMETRY I. Freshman year, fall term. Lectures, two hours; drafting-room practice, two hours. Three credits.

The course includes projection of solids; rotation in space; sections of solids and simple objects; development of surfaces; construction of the conic-section lines; isometric projection; exercises in lettering, inking, and shading.

5.—DESCRIPTIVE GEOMETRY II. Freshman year, winter term. Lectures, two hours; drafting-room practice, two hours. Three credits. Prerequisite: Descriptive Geometry I.

The course includes projection, rotation, and measurement of the straight line and the angle in space; change of ground line; oblique projection; the plane and its traces; various problems pertaining to the straight line and the plane.

6.—DESCRIPTIVE GEOMETRY III. Freshman year, spring term. Lectures, two hours; drafting-room practice, two hours. Three credits. Prerequisite: Descriptive Geometry II.

The single and double curved surfaces of revolution; their tangents and tangent planes; development of surfaces of revolution; sections and interpenetrations of the cylinder, the cone, and the sphere; construction and sections of the hyperboloid of revolution and the paraboloid form the matter of the course.

7.—COLOR AND DESIGN I. Freshman year, spring term. Drafting-room practice, four hours. Two credits.

The course includes discussion of the nature and influence of color, its use and abuse, and the principles that underlie good design and consistent, harmonious color combinations. Original designs in construction and decoration as applied to fabrics, dress, and articles of common use in the home are treated, that young women may recognize and appreciate that which is beautiful and appropriate, and may become more discriminating as purchasers.

8.—SHADES AND SHADOWS. Sophomore year, fall term. Drafting-room practice, four hours. Two credits. Prerequisite: Descriptive Geometry II.

Shadows upon the planes of projection; shadows upon oblique planes and curved surfaces; shades; exercises in brush shading, constitute the subject matter of the course.

9.—RESIDENCES. Sophomore year, fall term. Class work, four hours. Four credits.

The course comprises lectures on location, arrangement, construction, decoration, and sanitation of residences; study of modern residence styles; drawing to scale of plans, elevations, sections, and details of characteristic residences, involving construction in lumber, brick, stone, and concrete.

10 to 12.—ARCHITECTURAL DRAWING I, II, AND III. Sophomore year, fall, winter, and spring terms. Drafting-room practice, six hours; three credits.

The first term is given to the study of Gothic and Romanesque ornaments, tracery windows, and other details, from plaster models and blueprints. The second term takes up the analysis and study of standard forms of the five orders. The third is devoted to the study of the modern residence and the school building.

13.—HISTORIC ORNAMENT. Sophomore year, winter term. Class work, four hours. Four credits.

This is a course of illustrated lectures on the standard forms of Greek, Roman, and Gothic moldings; the Etruscan, Doric, Ionic, Corinthian and composite columns and their entablatures; the lotus, anthemion, acanthus, and laurel ornament; Roman, medieval, and modern lettering; the ornament of the Gothic period.

14.—LINEAR PERSPECTIVE. Sophomore year, winter term. Drafting-room practice, four hours. Two credits. Prerequisite: Geometrical Drawing.

Vanishing points, vanishing traces, measuring points, cylindric perspective and perspective corrections, are emphasized, and various exercises in representing geometric solids are given.

15.—WORKING DRAWINGS. Sophomore year, spring term. Drafting-room practice, four hours. Two credits.

This course comprises designing and drawing residence plans to scale; detail drawing of furniture and various modern conveniences.

16.—CLAY MODELING. Junior year, fall term. Laboratory, six hours. Three credits.

This course includes clay and plaster modeling of architectural details, historic ornaments, and decorative statuary; also methods of making plaster casts.

17.—COLOR AND DESIGN A. Junior year, winter term. Laboratory, six hours. Three credits.

The influence and nature of color, and the principles that underlie good design and harmonious color combinations. The use and abuse of color in building operations.

18.—HISTORY OF ARCHITECTURE I. Junior year, fall term. Class work, four hours. Four credits.

This study is taught by lectures, illustrated by photographs, plaster models, and stereopticon views. It deals with the development of the architecture of the ancient Egyptians, Chaldeans, Greeks, and Romans.

19.—HISTORY OF ARCHITECTURE II. Junior year, winter term. Class work, four hours. Four credits.

This course comprises a study of the architecture of the medieval and Renaissance periods—Byzantine, Romanesque, Moorish, Gothic, and Renaissance.

20.—HISTORY OF ARCHITECTURE III. Junior year, spring term. Class work, four hours. Four credits.

A study is made of the neo-Greek and the neo-Roman architecture; the revival of the Gothic and the Romanesque; the Colonial, the Mission, and modern American architecture.

21 to 25.—ARCHITECTURAL COMPOSITION I, II, III, IV, V. Beginning with the fall term of the junior year and extending through five consecutive terms. Drafting-room practice, six hours a week. Three credits each term.

The first term is given to the planning of a residence, and involves the preparation of a complete set of plans and elevations, sections and detail drawings. The second term takes up the planning of a Gothic church. The third is given to the planning of a Romanesque school building. The fourth takes up the planning of a small public building in the modern Renaissance. The fifth is given to work in modern steel and concrete architecture of a monumental style. Sets of blue-prints of all finished work must be left with the department, if required by the professor in charge of the work.

26.—HEATING. Junior year, winter term. Class work, four hours. Four credits.

The subject is taught by lectures dealing with the phenomena and laws of heat generation and propagation, systems of heating by means of air, water, and steam, modern methods of ventilation.

27.—MURAL DECORATION. Junior year, spring term. Drafting-room practice, six hours. Three credits. Prerequisite: Color and Design A.

Each student is required to make a series of large water-color studies of interior wall-decoration schemes, including original designs for borders and centerpieces.

28.—PUBLIC BUILDINGS. Senior year, fall term. Class work, four hours. Four credits. Prerequisites: Residences; Historic Ornament.

The course embraces lectures on location, floor arrangement, building materials, style, interior finish, decoration, etc., of schoolhouses, churches, libraries, courthouses, exposition buildings, and other public buildings.

29.—PLUMBING. Senior year, fall term. Class work, two hours. Two credits. Prerequisite: Sanitary Biology I and II.

This course comprises lectures on water supply, plumbing and sewering of residences; study of city plumbing ordinances and of disposition of sewage.

30.—MUNICIPAL IMPROVEMENTS. Senior year, fall term. Class work, four hours. Four credits.

This is a course of lectures on sidewalk construction, guttering and paving, sanitary sewers and sewage disposition, water supply, etc.

31.—BEAMS AND ARCHES. Senior year, fall term. Class work, three hours. Three credits. Prerequisite: Graphic Statics.

This is a course of lectures on the statics of steel and wood beams, posts, and struts, stone lintels, arches and concrete, reinforced concrete construction. Text, Kidder's *Handbook for Architects.*

32.—INK RENDERING. Senior year, fall term. Drafting-room practice, four hours. Two credits. Prerequisite: Linear Perspective.

The course includes perspectives of buildings and ornamental details; rendering in ink; studio methods.

33.—TRUSSES. Senior year, winter term. Class work, two hours; laboratory, four hours. Four credits. Prerequisite: Beams and Arches.

The course deals with methods of construction and graphic analysis of standard wood and steel trusses. Text, Kidder's *Handbook for Architects.*

34.—SPECIFICATIONS. Senior year, winter term. Class work, four hours. Four credits.

The course comprises discussion and preparation of standard specifications for some of the residences and public buildings planned by the student in the classes in composition; estimates of the materials and labor required in erecting and completing these buildings; methods of making lump estimates; discussion of the principles and form of building contracts; study of the legal relations of the architect, the owner, and the contractor; discussion of state laws concerning the erection of public buildings; labor laws; lien laws; city ordinances; building permits; building insurance; contracts and bonds.

35.—ARCHITECTURAL SEMINAR. Senior year, winter term. Class work, four hours. Four credits.

The course includes a critical study of public buildings, such as the Manhattan library, the Riley County courthouse, the buildings of the College, etc., as well as study and discussion of the work of American architects, such as Smithmeyer, Upjohn, and Richardson. A critical study is made of the competitive designs for the Cathedral of St. John the Divine, New York, the building of the University of California, etc.

36.—COLOR RENDERING. Senior year, winter term. Drafting-room practice, four hours. Two credits.

This is a course in rendering of buildings with their landscape environments, by means of ink or sepia washes, or in water color.

37.—HOME ARCHITECTURE. Senior year, winter term. Drafting-room practice, four hours. Two credits. Required in the course in home economics.

This is a study, and drawing in ink, of floor plans, details, and front elevations of modern residences.

38.—HOME DECORATION. Senior year, spring term. Drafting-room practice, four hours. Two credits. Required in the course in home economics.

This is a study of design in its application to the home, its plan, furniture, and decorations. Emphasis is laid upon the refining and educating influence of well-chosen and appropriate decoration, the importance of simplicity being urged. Lectures are given on the fine arts and the handicrafts, teaching that the home should show that fine art and industrial art are not to be considered separately. Problems in planning and decorating houses are discussed.

39.—LANDSCAPE ARCHITECTURE. Senior year, spring term. Class work, four hours. Four credits.

The principles of landscape design, location and construction of roads and walks, the disposition of trees, shrubs, lawns, and water as landscape features are discussed and studied.

40.—LANDSCAPE DESIGN. Senior year, spring term. Drafting-room practice, eight hours. Four credits.

Each student is required to draw and finish in water color a set of plates representing his original designs for a home lot, a public square, a campus, and a small park.

41.—ARCHITECTURAL THESIS. Senior year, spring term. Drafting-room practice, fourteen hours. Seven credits.

In the winter and spring of the senior year the student prepares a thesis, consisting of a set of original drawings, complete with details and specifications, for a public building. This work must be done in the drafting room of the department and under the supervision of the professor of architecture, who decides on the cost limit and style of the building and the size and number of plates required.

42.—FARM ARCHITECTURE. Elective, spring term. Drafting-room practice, eight hours. Four credits.

The course comprises the preparation of drawings and specifications for barns, dairy stables, and other farm buildings.

Civil and Highway Engineering

Professor CONRAD
Professor GEARHART
Associate Professor WALKER
Instructor FRAZIER

The instruction in civil and highway engineering is given by means of lectures and recitations, and by practice in the field, in the drafting room, and in the laboratory. The technical work begins in the fall term of the sophomore year, in which the work in surveying is started. The heaviest technical work of the course falls in the junior and senior years, during which, in addition to studies in other departments, courses are given in civil engineering drawing and in the analysis of stresses and framed structures, structural design, drainage and irrigation engineering, construction and design in masonry and concrete, railways, highway engineering, astronomy, and geodesy. During the entire senior year considerable time is devoted to thesis work.

In addition to the laboratory equipment found in the mechanical and electrical engineering laboratories, which is available to civil engineering students as well, the Department of Civil and Highway Engineering possesses a good assortment of transits, levels, plane tables, tapes, and chains.

COURSES IN CIVIL ENGINEERING

1.—SURVEYING. Sophomore year, fall and spring terms. Class work, one hour; field work, four hours. Three credits. Prerequisite: Trigonometry.

This is a brief course in the care and use of engineer's surveying instruments. The greater part of the time is devoted to exercises and practical problems involving the use of the transit and level. Text, Pence and Ketchum's *Surveying Manual.*

2.—SURVEYING I. Fall term. Class work, four hours; field and drafting-room work, six hours. Seven credits. Prerequisite: Trigonometry.

The textbook work in this course deals with the use and care of instruments, land topographic and hydrographic surveying. The field and drafting work is devoted to exercises in the use of engineer's surveying instruments and plotting plane surveys. Text, J. B. Johnson's *Theory and Practice of Surveying.*

3.—FOUNDATIONS. Spring term. Class work, three hours. Three credits.

This course is devoted to a study of the principles underlying the design and construction of foundations of all characters in common use at the present time. Text, Fowler's *Ordinary Foundations.*

4.—SURVEYING II. Fall term. Class work, four hours; field and drafting-room work, six hours. Seven credits. Prerequisites: Surveying I.

Recitation work in this course deals with city and mine surveying, computations of volumes, and railroad curves. The field and drafting work is devoted principally to topographical surveying and plotting. Text, J. B. Johnson's *Theory and Practice of Surveying.*

5.—CIVIL ENGINEERING DRAWING I. Winter term. Drafting-room work, four hours. Two credits. Prerequisites: Mechanical Drawing I and II.

This course is devoted to the application of the elementary principles of stereotomy, shades and shadows, isometric drawing, and perspective. These principles are explained to the student by such short lectures as seem necessary for the purpose. No textbook is used.

6.—CIVIL ENGINEERING DRAWING II. Spring term. Drafting-room work, eight hours. Four credits. Prerequisite: Civil Engineering Drawing I.

This is, during the first part of the term, a continuation of the course in graphic statics. About three-fourths of the term is devoted to the design of roof trusses of timber and steel. Text to be selected.

7.—BRIDGE STRESSES. Fall term. Class work, four hours. Four credits. Prerequisites: Applied Mechanics I and II.

This course involves the study of the algebraic method of computing the stresses in bridges and buildings, leading up to the subject of structural design the following term. Text, Merriman and Jacoby's *Roofs and Bridges,* Part I.

8.—WATER SUPPLY AND SEWERAGE. Fall term. Class work, four hours. Four credits. Prerequisite: Hydraulics.

This course deals briefly with the problems of designing and constructing sewer systems and disposal plants for cities of moderate size. Water supply for cities is studied from the standpoints of consumption, collection, storage, distribution, and purification. Texts, Turneaure & Russell's *Public Water Supplies* and Folwell's *Sewerage.*

9.—BRIDGE DESIGN. Winter term. Class work, three hours; drafting-room exercises, six hours. Six credits. Prerequisites: Bridge Stresses, and Civil Engineering Drawing II.

This is a study of the design of timber and of metal structures. In the drafting-room the time is chiefly devoted to working out the details of a plate girder and of a railroad or highway bridge. Text, Merriman and Jacoby's *Roofs and Bridges,* Part III.

10.—RAILWAYS I. Winter term. Class work, three hours. Three credits. Prerequisites: Surveying I and II.

This is a short course in the theory of railroad engineering based on Wellington's economic theory. Considerable time is also devoted to the study of track construction and maintenance, and of the design of the yards and terminals. Text, Raymond's *Elements of Railroad Engineering,* and Nagel's *Field Manual for Railroad Engineers.*

11.—MASONRY AND CONCRETE. Winter term. Class work, three hours; drafting-room work, four hours. Five credits. Prerequisites: Applied Mechanics I, II, and III.

The classroom work takes up the study of the design and construction of structures of masonry and concrete, both plain and reinforced. The time spent in the drafting room is devoted to the design of concrete and masonry retaining walls, dams, arches, slab and girder bridges. Text, Taylor and Thompson's *Concrete.*

12.—STRUCTURES. Winter term. Three recitations per week and six hours in the drawing room. Six credits. Prerequisites: Applied Mechanics II, and Drainage and Irrigation I.

This course is devoted to a study of the design and construction of the various structures of timber, steel, masonry and concrete with which the irrigation engineer has to deal. Text to be selected.

13.—ASTRONOMY. Winter term. Class work, two hours; laboratory, two hours. Three credits. Prerequisites: Trigonometry, Surveying II.

This course is given as a preparation for geodesy the following term. The course, as given, is a practical one, designed to familiarize the student with methods of determining latitude, longitude, and azimuth with the ordinary engineer's surveying instruments. Text, Hosmer's *Practical Astronomy.*

14.—RAILWAYS II. Spring term. Drafting-room or field exercises, eight hours. Four credits. Prerequisite: Railway Engineering I.

This is a continuation of the preceding course. The time is devoted principally to the field and office work of railway engineering. In the field a reconnoissance and survey of a short line is made, and the office work consists in working up the maps, profiles, and estimates from the survey. Texts, Raymond's *Elements of Railroad Engineering,* and Nagle's *Field Manual for Railroad Engineers.*

15.—GEODESY. Spring term. Class work, two hours; field work, four hours. Four credits. Prerequisites: Surveying I and II; Astronomy.

Here the precise methods of surveying and leveling are studied. In the field the time is devoted to practice with the plane table, base-line measurement, triangulation, and precise leveling. Text, J. B. Johnson's *Theory and Practice of Surveying.*

COURSES IN HIGHWAY ENGINEERING

1.—HIGHWAY ENGINEERING. Spring term. Class work, three hours. Three credits.

The work in the class room is devoted to a study of the theory and practice of economic highway and pavement construction and maintenance, including a study of the needs of traffic, of its effect on the road surface, and of the materials of construction. Text, Baker's *Roads and Pavements.*

2.—HIGHWAY ENGINEERING I. Fall term. Four recitations a week and six hours in the laboratory. Seven credits.

The recitation work deals with the economics of highway location, construction and maintenance, dealing principally with country highways. The laboratory work is devoted to a study of the characteristics of the principal road-building materials and the standard methods of testing. Text to be selected.

3.—HIGHWAY ENGINEERING II. Winter term. Four recitations a week. Four credits. Prerequisite: Highway Engineering I.

This course is devoted principally to a study of the construction and maintenance of modern types of improved surfaces for roads and pavements. Texts to be selected.

4.—HIGHWAY ENGINEERING III. Spring term. Three recitations a week; eight hours of field and drawing-room work. Seven credits. Prerequisite: Highway Engineering II.

The recitation work is devoted to a study of road laws and administration in the various sections of the United States and Europe. The field and drawing-room work aims to give the student practice in making surveys for highways, mapping, making estimates and drawing up specifications. Texts to be selected.

5.—SPECIFICATIONS AND INSPECTION. Spring term. Two recitations. Two credits. Prerequisite: Highway Engineering II.

This is a course dealing with the matter of drawing specifications for various standard types of road construction and the inspections of materials and construction work. Text to be selected.

6.—ROAD MACHINERY LABORATORY. Fall term. Four hours laboratory work. Two credits.

The design of this course is to familiarize the student with the construction and use of machinery used in the construction and maintenance of roads.

COURSES IN IRRIGATION AND DRAINAGE ENGINEERING

1.—Drainage and Irrigation I. Fall term. Class work, three hours. Three credits. Prerequisite: Hydraulics.

In this course a study is made of the application of engineering principles to the design and construction of drainage and irrigation works. Considerable attention is paid to the development of ground-water supplies for irrigation. Any senior engineering student may enter the course. Texts, Elliot's *Engineering for Land Drainage*, and Newell and Murphy's *Principles of Irrigation Engineering.*

2.—Drainage and Irrigation II. Winter term. Three recitations a week. Three credits. Prerequisite: Drainage and Irrigation I.

This is a library and textbook course dealing primarily with the agricultural side of drainage and irrigation. Among the questions considered are the amount of water required by different crops, the best time to apply water for different crops, the effect on various crops of the depth below the surface of ground water, methods of preventing the deposits of salts injurious to vegetation and of removing existing deposits of such salts. Text to be selected.

3.—Drainage and Irrigation III. Spring term. Field and drafting-room work, six hours. Three credits.

It is the aim of this course to give the student practice in the surveys for drainage and irrigation projects, plotting maps and drawing up specifications and estimates.

Electrical Engineering

Professor Reid
Assistant Professor Lane

Instruction in this course is given by means of textbooks, lectures, and laboratory periods. The class work is carefully illustrated by means of demonstration apparatus and the projection lantern. The course is designed to provide the necessary preparation for young men who desire to engage in the practical field of electrical engineering, or for those who desire to assume the control of central stations as managers, as superintendents, or as consulting engineers.

The electrical laboratory for the work of the third year is provided with standard instruments of measurements, including standards of resistance, self-induction, capacity, etc. A complete line of standard makes of ammeters, voltmeters, wattmeters, and galvanometers is also provided. The different laboratories of the department are supplied with electric current from the following sources: 120-volt storage-battery circuit; 110-volt direct-current circuit; 110-volt alternating-current circuit; 220-volt direct-current circuit. Voltages up to 60,000 can be produced in the dynamo laboratory for testing purposes.

The electrical engineering laboratory is provided with a number of standard commercial machines, among them a 30-kilowatt 2300-volt polyphase alternating-current generator, a 15-kilowatt 125-volt alternating-current generator, a 7½-kilowatt synchronous converter, single- and three-phase induction motors, a 5-horsepower phase-wound induction motor, a 20-horsepower auxiliary pole 220-volt direct-current motor, a 26-horsepower 220-volt direct-current motor, a 15-kilowatt 125-volt generator, a 4½-kilowatt 125-volt direct-current generator, a Wood arc machine, a 60-cell 160-ampere-hour storage battery, current transformers, arc lamps, constant potential transformers, 20,000- and 60,000-volt testing transformers, marble and slate switchboards, a Tirrel regulator, speed controllers, and a full line of ammeters, voltmeters, wattmeters, etc., for testing purposes.

COURSES IN ELECTRICAL ENGINEERING

1.—THEORY OF ELECTRICITY I. Junior year, fall term. Recitations and lectures, four hours; laboratory, two hours. Five credits. Prerequisites: Engineering Physics II; Calculus III.

This course is an extension of the work in electricity in Engineering Physics II, and is a prerequisite to work in electrical engineering proper. A study is made of the phenomena and fundamental laws and principles of static electricity, the galvanic current, magnetism, and electromagnetism. Emphasis is laid upon the ultimate importance to the student of a thorough understanding of these subjects. Text, Pender's *Principles of Electrical Engineering.*

Laboratory.—The laboratory course continues the work of the classroom in giving the application of the fundamental principles, the experiments being so arranged as to follow the theoretical development of the subject.

2.—THEORY OF ELECTRICITY II. Junior year, winter term. Recitations and lectures, three hours; laboratory, two hours. Four credits. Prerequisite: Theory of Electricity I.

This course is a continuation of the work begun in the fall term. It deals primarily with the general principles of electromagnetic induction, and gives an elementary treatment of alternating currents, including the effect of inductance and capacity. Text, Pender's *Principles of Electrical Engineering.*

Laboratory.—This work is a continuation of the laboratory work done in the preceding course, and gives the student a wide range of work in the use and manipulation of some of the higher-grade instruments used in electrical measurements.

3.—DIRECT-CURRENT MACHINES I. Junior year, winter term. Recitations or lectures, four hours; laboratory, four hours. Six credits. Prerequisite: Theory of Electricity II.

The work consists of a detailed study of the fundamental principles of magnetic and electric circuits and their application to the various types of direct-current machines. Numerous problems involving the application of the principles are given as a part of the course. The class work is planned to coördinate with the work in the electrical engineering laboratory. Text, Franklin and Estey's *Elements of Electrical Engineering*, Vol. I.

Laboratory.—A series of experiments is outlined which is designed to necessitate careful, accurate measurement. The student is obliged to make all electrical connections with the necessary instruments in the circuit and to record the required data. From the laboratory records a written report upon each experiment or test must be submitted. The laboratory exercises include tests for armature and field resistance, potential curves, machine characteristics, motor and generator efficiencies.

4.—DIRECT-CURRENT MACHINES II. Junior year, spring term. Lectures or recitations, four hours; electrical engineering laboratory, four hours. Six credits. Prerequisite: Direct-Current Machines I.

This course is a continuation of Direct-Current Machines I. It involves a detailed study of the various types of direct-current machinery with respect to theory and operation. The latter part of the course is devoted to a special examination of the different methods of testing generators and motors, and to the special application of the different classes of machines to commercial uses. Text, Franklin and Estey's *Elements of Electrical Engineering*, Vol. I.

Laboratory.—Special attention is given in this course to the different methods of determining generator and motor efficiencies and to the proper tabulation and interpretation of results.

5.—ELECTRICAL INSTRUMENTS AND CALIBRATION. Junior year, spring term. Lectures and recitations, two hours; calibration laboratory, four hours. Four credits. Prerequisites: Theory of Electricity I and II.

This course includes a study of the different types of electrical measuring instruments and their application to electrical engineering testing. Text, Roller's *Electric and Magnetic Measurements*, supplemented by lectures.

Laboratory.—The laboratory work in this subject includes the calibration of both direct- and alternating-current measuring instruments and their uses in measuring current, potential power, resistance, inductance, and capacity.

6.—DIRECT-CURRENT MACHINE DESIGN. Senior year, fall term. Lectures, two hours; computation, four hours. Four credits. Prerequisite: Direct-current Machines II.

The purpose of the course is to acquaint the student with the principles of commercial design of direct-current machinery. Each student is required to make the necessary calculations and drawings for a direct-current generator.

7.—ALTERNATING-CURRENT MACHINES I. Senior year, fall term. Recitations or lectures, four hours; laboratory, four hours. Six credits. Prerequisites: Calculus III, Theory of Electricity II.

The work consists of a mathematical treatment of alternating-current phenomena. A study is made of the vector method of treating alternating-current problems. The solution of problems involving single and polyphase circuits forms an important part of the course. Text, Franklin and Estey's *Elements of Electrical Engineering*, Vol. I; Swenson and Frankenfield's *Testing of Electromagnetic Machinery.*

Laboratory.—It is the aim of this course to provide a series of experiments illustrating the theoretical work of the lecture room. Practice is given in the accurate measurement of capacity and inductance, and the effect of each upon the circuit. The latter part of the course is devoted to a study of polyphase circuits.

8.—ELECTRICAL ENGINEERING M-I. Senior year, fall term. Lectures or recitations, four hours; laboratory, two hours. Five credits. Prerequisites: Engineering Physics II and Calculus III.

This course covers the subject of direct-current machines with reference to the fundamental laws of the electric circuit; the principles of direct-current machinery; and the more important commercial tests. Text, Sheldon's *Direct-Current Machines.*

Laboratory.—Practice is given in the proper use of electrical measuring instruments. The experiments include a variety of tests requiring accurate observation, and a knowledge of the theory of dynamo machines. The various standard characteristic and efficiency tests are given. A written report on each test is required.

9.—ELECTRICAL ENGINEERING M-II. Senior year, winter term. Lectures and recitations, four hours; laboratory, two hours. Five credits. Prerequisites: Engineering Physics II; Calculus III.

The work covers briefly the important principles of alternating-current phenomena. The leading types of alternating-current machinery and apparatus are discussed with reference to their operation and their adaptability to different classes of service. Text, Sheldon's *Alternating-Current Machines.*

Laboratory.—The experimental work in this course includes practice in the use of alternating-current instruments; standard tests of alternators, motors, and transformers; and methods of operating the different types of alternating-current machinery.

10.—ALTERNATING-CURRENT MACHINES II. Senior year, winter term. Recitations or lectures, four hours; laboratory, four hours. Six credits. Prerequisite: Alternating-Current Machines I.

This is a continuation of Alternating-Current Machines I. The course consists of a study of the theory of alternating-current machinery, alternators, synchronous motors, induction motors, transformers, and the various devices used in connection with alternating-current work. A study is also made of the application of the different types of machinery to industrial uses. Text, Franklin and Estey's *Elements of Electrical Engineering*, Vol. II; Swenson and Frankenfield's *Testing of Electro-Magnetic Machinery.*

Laboratory.—This laboratory course consists of a series of experiments involving special and commercial tests of alternators, synchronous motors, transformers, and the different types of alternating-current machinery and apparatus.

11.—ILLUMINATING ENGINEERING. Senior year, spring term. Lectures or recitations, two hours; laboratory, two hours. Three credits.

This course is devoted to a study of photometry and light standards and the principles of illumination. The different types of incandescent and arc lamps are discussed with reference to their efficiency and adaptability to different classes of lighting. Systems of street illumination are also studied.

12.—TELEPHONE ENGINEERING. Senior year, winter term. Class work, three hours; laboratory, two hours. Four credits.

This course consists of a consideration of the principles of acoustics and alternating phenomena involved in telephone practice. A detailed investigation is made of telephone apparatus and circuits, with reference to their adaption to various kinds of telephone service. This is followed by a study both of the design and maintenance of telephone lines and central-office apparatus, and of central-office methods, the selection of apparatus, and methods of handling telephone traffic. Text, Abbots's *Telephony.*

13.—ELECTRICAL ENGINEERING C. Senior year, spring term. Recitations or lectures, three hours; laboratory practice, two hours. Required in the course in civil engineering. Prerequisites: Engineering Physics III; Calculus III.

This work is designed to cover briefly the fundamental principles of direct-current and alternating-current machinery. Emphasis is laid upon the proper installation and operation of the different classes of machines.

Laboratory.—The laboratory practice is designed to give the student a knowledge of the most important commercial tests. The proper use of electrical instruments is emphasized. A written report of each laboratory test is required.

14.—ALTERNATING-CURRENT MACHINE DESIGN. Senior year, spring term. Lectures, one hour; laboratory, two hours. Two credits. Prerequisite: Alternating-Current Machines II.

This course embraces the elementary principles underlying the design of alternating-current apparatus. Students are required to make calculations and drawings for an alternating-current machine.

15.—GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY. Senior year, spring term. Recitations or lectures, four hours. Four credits.

This course is designed to cover station operation and management, methods of power transmission, and systems of distribution. Each student is assigned an important electrical power station, upon which a detailed written report is required. Text, Ferguson's *Elements of Electrical Transmission.*

16.—POWER PLANT DESIGNS AND SPECIFICATIONS. Senior year, spring term. Lectures, one hour; laboratory, six hours. Four credits.

This work relates to the design and equipment of a modern power plant. Complete specifications for the necessary machinery and apparatus, with drawings showing the plan of the building and the location of the machinery and apparatus, are required.

17.—POWER AND LIGHTING. Senior year, spring term. Class work, three hours; laboratory, two hours. Four credits.

The work is planned to cover briefly the principles of illumination, the proper distribution of lighting units, photometric measurements, and inspection work, as based on the *National Electric Code.*

18.—SEMINAR E-I, E-II. Junior year, fall and winter terms, and senior year, winter term, respectively. The first course has one hour of class work with one credit; the last is a two-hour course with two credits.

The work of this course is intended to give students of electrical engineering the opportunity to keep informed regarding the latest inventions and research work along the special line which they have chosen. Reviews of current electrical literature are required, and class discussions of articles reviewed are made the basis of the class work.

19.—THESIS. Required in the course in electrical engineering.

The selection of a subject for thesis work, in consultation with the head of the department, is made at the beginning of the winter term. The work is continued during the winter and spring terms. Every opportunity is given the student to work out original ideas as to design or operation.

Printing

Superintendent STROTHER
Assistant ALLEN

The Department of Printing had its inception when *The Kansas Industrialist* was established, in 1875. The demands made upon the department have necessitated a gradual increase in equipment and facilities, until at present it occupies the entire first floor and basement of Kedzie Hall. In addition to printing and mailing *The Kansas Industrialist* each week during the College year, the large amount of general printing for the numerous departments of the College furnishes a wide range of work and keeps the plant in constant operation during the entire twelve months.

From the beginning, printing-trade practice has been offered to students, as the facilities of the department make possible.

COMPOSING ROOM. The equipment consists of ten racks of body type, two dumps, galley racks, proof press, ten cabinets of display type, five imposing stones, two lead and slug racks, make-up rack, ink stones, galleys, chases, and other accessories.

Folding and Stock Room. The equipment consists of tables for hand folding, two wire-stitching machines, one 32-inch power paper cutter, one 26-inch hand cutter, one interchangeable perforating, punching, and round-cornering machine, racks for storing stock, and other necessary appliances.

Pressroom. The equipment consists of one two-revolution cylinder press, one drum-cylinder press, three platen presses, one imposing stone, drying racks, tables, trucks, and other accessories. All machines requiring power are driven by individual electric motors.

Shop Practice

Associate Professor Carlson
Instructor House
Instructor Hollar
Instructor Hayes
Instructor Grant
Assistant Yost
Assistant Parker
Assistant Turnbull
Assistant Lathrop
Assistant Ball
Assistant Brakeman
Assistant ———

The work in the shops is planned to meet the needs of three classes of students: (1) those in the course in agriculture who expect to use the skill gained in the shops in their after work on the farm; (2) those in the manual-training option of the course in general science who need to secure a sufficient knowledge of the principles underlying shop work, and sufficient skill in the performance of various operations, to be able to instruct others; (3) those in the courses in engineering whose need is to secure a thorough knowledge of the methods of performing various kinds of shop work; of the machine best suited for the different purposes; of the amount of work that may be expected of the different machines and from the workmen under different conditions.

The equipment of the Department of Shop Practice is set forth to a certain extent below.

Wood Shop. This room is 40 by 90 feet; it contains 252 separate sets of tools, and benches for 60 students in each class.

Pattern Shop. This room is 45 by 81 feet, and contains sixteen ten-inch by four-and-one-half-foot wood-turning lathes and one eighteen-inch by twelve-foot J. A. Fay & Co. pattern makers' lathe fully equipped with tools and chucks; eight pattern makers' double benches, equipped with rapid-acting vises and a complete set of tools.

Woodworking Machinery Room. This room is 35 x 42 feet, and contains one Dietzwell wood planer, one Cordsman Meyers friezer, one thirty-four-inch band saw, one Beach jig saw, one Fay Combination circular saw, one Fay & Egan power mortiser, one Fay & Egan sandpapering machine, one K. S. A. C. sensitive drill, one Seneca Falls foot mortiser, besides the necessary grindstones and work benches.

Machine Shop. This room is 40 by 170 feet, and contains thirteen engine lathes, as follows: One fourteen-inch Hendey-Norton lathe, two fourteen-inch Flather lathes, one thirteen-inch Lodge & Davis lathe, one sixteen-inch Lodge & Shipley combination engine and turret lathe, two fourteen-inch Reed lathes, five fourteen-inch K. S. A. C. lathes, and one twenty-eight-inch by twenty-foot American lathe equipped with block to raise it to sixty-inch swing, one K. S. A. C. speed lathe, one Brown & Sharp No. 2 universal milling machine, one K. S. A. C. (Hendey-Norton pattern) shaper, one K. S. A. C. (Pratt & Whitney patterns) shaper, one Gray twenty-six-inch by six-foot planer, one Niles fifty-one-inch vertical turning and boring mill, one Baker Bros. key seater, one Barnes thirty-four-inch self-feed drill press, one Rogers twelve-inch sensitive drill press, two K. S. A. C. twelve-inch sensitive drill presses, one K. S. A. C. (Bemis Miles patterns) twenty-inch double-traverse quick-return shaper, two Morse & Dexter valve reseating machines, one Walker universal grinder, one K. S. A. C. special drill grinder, one power hack saw, one Emerson direct-connected motor polishing machine, one bolt and pipe machine taking pipe up to two inches, one pipe machine taking pipe up to eight inches, benches and tools for fifty students, and a tool room completely stocked with the necessary tools.

BLACKSMITH SHOP. This room is 50 x 100 feet, and is equipped with thirty-three Sturtevant down-draft forges for students' use and two large special Sturtevant forges for general use. Each forge has anvil and complete set of forging tools, and is supplied with forced draft and power exhaust. In addition to the general tools for a fully equipped blacksmith shop, there is also installed a drill press, punch and shear, emery grinder, tire bender, tire shrinker, and a number of pieces of special apparatus built by the department.

IRON FOUNDRY. This room is 27 x 100 feet. It is equipped with a one-and-one-half-ton Calliau cupola, one-and-one-half-ton K. S. A. C. steel crane, core oven five by six by seven feet (arranged so that it can be heated with either coke or gas), one car, track and turntable, one two-by-three-foot K. S. A. C. rumbler, one K. S. A. C. emery grinder, one K. S. A. C. molding machine, an exceptionally large number of flasks, both wood and iron, ladles, etc.

BRASS FOUNDRY. This room is 24 x 34 feet. It is equipped with one twenty-one by thirty-six-inch brass furnace, crucibles, flasks, molding tubs, benches, cases, racks and all necessary tools for bench and floor molding.

AMPHITHEATER. This room is 54 x 54½ feet. It is adjacent to the blacksmith shop and iron and brass foundries, and is equipped with forge, anvil and forge tools, bench, molding trough and molding tools, blackboard, etc., for lectures and demonstration work.

LOCKER ROOM. This room is 36 x 40 feet. It is conveniently located, and is equipped with 244 special metal lockers for the use of students taking work in the machine shop, blacksmith shop, foundry and engineering laboratory. A portion of this is made a separate locker-room and bath-room for the use of the shop foreman, and contains seven metal lockers.

COURSES IN SHOP PRACTICE

1.—BLACKSMITHING I. Lecture, one hour; shop work, four hours. Three credits.

This is a course in the forging of iron, and is designed to teach the principles and operations of drawing, bending, upsetting, welding, twisting, splitting, and punching. A study is made of the manufacture of iron and steel, composition and heat treatment of steel, and of the proper methods of making forgings and tools. Tools required: a two-foot rule and a pair of five-inch outside calipers.

2.—BLACKSMITHING II. Shop work, four hours. Two credits. Prerequisite: Blacksmithing I.

Advanced work in the forging of iron and in the manufacture of steel tools. Instruction is given in hardening, tempering, case-hardening and annealing. Tools required: same as Blacksmithing I.

3.—FOUNDRY. Lecture, one hour; shop work, four hours. Three credits.

Practice is given in floor, bench and machine molding, in core making, and in casting in iron, copper, brass, and special alloys. A study is also made of modern foundry construction, equipment, materials and methods.

4.—PATTERN MAKING. Lecture, one hour; shop work, four hours. Three credits. Prerequisite: Foundry.

This course comprises a series of exercises embodying the principles governing pattern construction in making plain and split patterns, including core prints and core boxes, after which practical patterns are made of machines and machine parts.

5.—MACHINE SHOP I. Shop work, four hours. Two credits. Prerequisite: Foundry.

Practice is given in chipping, filing, shaper and planer work, scraping, drilling, and the cutting of right-hand, left-hand, and double threads, and knurling on the lathe. Tools required: a four-inch scale or (B. & S.) slide caliper, a nine-inch combination set No. 7 graduation, one pair five-inch outside calipers, one pair five-inch inside calipers, one center drill, one center gauge (B. & S.), and one pair of three-inch dividers.

6.—MACHINE SHOP II. Shop work, four hours. Two credits. Prerequisite: Machine Shop I.

This course consists of progressive problems in turning and calipering, boring, reaming and taper turning and threading on the lathe, exercises in chucking, the use of forming tools, practice on key-seating machine. A spur gear is made on the milling machine. A study is also made of cutting edges and tool adjustments best suited to the different metals, together with a study of cutting speeds and feeds.

7.—ADVANCED WOODWORK. Lecture, one hour; shop work, four hours. Three credits. For students in the course in architecture.

This is a course in bench and machine work in making some of the more common building details, such as porch newels and rails, plain and fancy moldings, cornices, etc.

8.—MACHINE SHOP III. Lecture, one hour; shop work, four hours. Three credits. Prerequisite: Machine Shop II.

This course takes up work on the turret lathe and boring mill. Practical work is also given with jigs, templets, and a study made of the rapid production of duplicate parts, belts, lacings, and methods of belt connections, compound and differential indexing, and the cutting of spiral gears on the milling machine.

9.—WOODWORK III-G. Lectures and recitations, two hours; shop work, eight hours. Six credits. Elective in the course in general science.

A course is given in woodworking suitable for use in the upper grammar and high-school grades. Each student completes a set of exercises suitable for those grades. Models showing progressive steps are made for the purpose of illustrating the proper methods of procedure in working out the different exercises. A study is made of the selection and cost of the equipment and material used in this work.

10.—MACHINE SHOP IV. Lectures, one hour; shop work, six hours. Four credits. Prerequisite: Machine Shop III.

The time of this course is devoted to the construction of complete machines and machine parts, from drawings and blue-prints. A study will be made of the different machine tools from assigned catalogue work, with regard to the economical and efficient production of different classes of product.

11.—WOODWORK IV-G. Lectures and recitations, one hour; shop work, four hours. Three credits. Elective in the course in general science. Prerequisite: Woodwork III-G.

This is a continuation of Woodwork III-G, with a study of cabinet construction best adapted to high-school grades. The work of this term includes a course in wood carving, in sinking backgrounds and in modeling curved surfaces. The course includes a study of the proper application of carving in ornamental articles of use.

12.—Wood Turning G. Lectures and recitations, one hour; shop work, four hours. Elective in the course in general science. Prerequisite: Woodwork III-G.

Exercises are first given in turning cylinders, cones, convex and concave curves, which involve the use of different wood-turning tools. The course involves turning between centers, on faceplates, and by means of hollow chucks. Some of the articles made are tool handles, dumb-bells, towel rings, typical vase forms, cups, goblets, etc. Tools required: one two-foot rule, one pair of three-inch dividers, one pair of five-inch outside calipers, one pair of five-inch inside calipers.

13.—Machine Shop V. Shop work, supplemented by lectures, four hours. Two credits. Prerequisite: Machine Shop IV.

This course is a continuation of Machine Shop IV, with practice in the making of taps, reamers, twist drills, dies and tool-making work.

14.—Machine Shop VI. Shop work, supplemented by lectures, four hours. Two credits. Prerequisite: Machine Shop V.

This is a continuation of Machine Shop V, with practice in the grinding of reamers, and milling cutters, and general tool work.

15.—Blacksmithing III-G. Lectures and recitations, one hour; shop work, four hours. Three credits. Elective in the course in general science. Prerequisite: Blacksmithing II.

Special drill in forge work is given in order to impart skill in the different operations. Progressive steps of different exercises are worked out, in order to illustrate the method of their construction.

16.—Blacksmithing IV-G. Lectures and recitations, one hour; shop work, two hours. Two credits. Elective in the course in general science. Prerequisite: Blacksmithing III-G.

This comprises a study of ornamental forge work in designing and making articles such as jardiniere stands, andirons, hinges, escutcheons, etc. A portion of the time is devoted to hammered metal work. Problems are worked out in copper and brass, which brings into use typical tools and operations in the handling of sheet metal.

17.—Machine Shop III-G. Lectures and recitations, one hour; shop work, four hours. Three credits. Elective in the course in general science. Prerequisite: Machine Shop II.

A course in machine-shop metal working, adapted to the conditions frequently found in high schools. A study is made of the selection of machines, tools, and general supplies; the proper arrangement of the shop, the location of shafting, and other shop problems.

COURSES IN FACTORY ENGINEERING

1.—Factory Engineering. Senior year. Winter term. Lectures and recitations, two hours. Two credits.

This course considers the selection of a locality and site for shops and manufacturing establishments; the grouping and design of the buildings, including the study of slow-burning and fire-proof construction; systems of illumination; equipment for the different departments; the methods of handling the raw material, from the point of its receipt through the several departments to the completion of the finished product, with the least amount of doubling back; methods of manufacturing. Text, Kent's *Mechanical Engineer's Pocketbook.* Prerequisites: Applied Mechanics III; Business Organization.

2.—FACTORY DESIGN. Senior year. Spring term. Drafting-room work, four hours. Two credits.

The knowledge gained in the shops and laboratories is applied to the design of a factory, shop or mill. Prerequisite: Factory Engineering.

Steam and Gas Engineering

Professor POTTER
Instructor SIMMERING
Assistant SANDERS
Assistant SHUTT
Assistant ———

The object of the instruction in this department is to give to the student the fundamental principles underlying the design, construction, selection, operation and testing of steam boilers, steam engines, and steam turbines; gas producers; gas and petroleum engines; compressed-air and refrigerating machinery; condensers and evaporators. These subjects are developed by thorough courses in engineering thermodynamics and in steam and gas engineering, and are followed in the fourth year by courses in power-plant engineering, in refrigeration, and in heating and ventilation. The classroom instruction of every course consists of lectures and recitations, which are paralleled by work in the drafting room and laboratory, and supplemented by numerous practical problems, trade catalogues, notes, and inspection trips requiring written reports.

STEAM ENGINEERING LABORATORY

In addition to the equipment installed especially for experimental purposes, all the heating, power, ventilating, and pumping equipment of the College subserves the further purpose of experimental work.

There are available for boiler tests three 125-horsepower high-pressure fire-tube boilers equipped with under-feed, chain-grate, and sight-feed stokers; two high-pressure water-tube 250-horsepower boilers, one being equipped with a Roney stoker and the other for hand firing. Besides the five high-pressure boilers, there are eight low-pressure boilers equipped with under-feed stokers. All of these boilers have full equipment of auxiliaries and are provided with pyrometers, draft gauges, flue-gas samplers, and other instruments for research and laboratory work.

The steam engineering laboratory contains eight steam engines with different types of valve gears, including plain slide valves, balanced valves, double valves, piston valves, Corliss valves. These engines range in power from six to two hundred and fifty horsepower. There is also a 300-horsepower De Laval steam turbine equipped with a surface condenser, dry vacuum pumps, wet vacuum pumps, and circulating pumps. A little compound reciprocating steam engine is also equipped so that it can be operated condensing or noncondensing. The engines in this laboratory are equipped with electric generators or with absorption brakes, the Corliss engine being provided with an Alden water brake.

The laboratory is also provided with various types of steam pumps, steam traps, and coal calorimeters, indicators, gauges, injectors, planimeters, pyrometers, and apparatus for testing gauges, indicators, and lubricants. Furthermore, the College has several types of steam traction engines and a road roller.

GAS ENGINEERING LABORATORY

The apparatus for gas engineering work includes two complete producer plants, with various types of scrubbers, saturators, blowers, a Carpenter coal calorimeter, a Junkers gas calorimeter, two types of pyrometers, and many different types of gas and oil engines, fans, a complete compressed-air plant, consisting of a steam engine, air compressors, and an air motor, Venturi and Pitot tubes, gas meters, and other small apparatus.

The College owns a gasoline tractor, and, through the courtesy of manufacturers, has on hand at all times several types of gasoline and oil traction engines.

COURSES IN STEAM AND GAS ENGINEERING

1.—STEAM AND GAS ENGINEERING I. Fall term. Lectures and recitations, four hours. Four credits. Prerequisite: Kinematics I.

A descriptive study of steam boilers, steam engines, and steam turbines. A study of the various types of fire-tube and water-tube boilers, reciprocating steam engines and turbines, valve gears, governors, and details of construction and operation. Texts: Peabody's *Valve Gears;* Peabody and Miller's *Steam Boilers;* Notes.

2.—STEAM AND GAS ENGINEERING II. Winter term. Lectures and recitations, three hours; laboratory, two hours. Four credits. Prerequisite: Steam and Gas Engineering I.

This is a continuation of the work given under Steam and Gas Engineering I, as well as a descriptive study of gas and oil engines, and gas producers, including carbureters, vaporizers, ignition systems, gas-engine governors, etc. Texts: Peabody & Miller's *Steam Boilers;* Jones' *Gas Engine.*

3.—STEAM AND GAS ENGINEERING III. Spring term. Lectures and recitations, three hours; laboratory, two hours. Four credits. Prerequisites: Steam and Gas Engineering; Calculus III.

A study of engineering thermodynamics, including the application of laws of gases and vapors to various thermodynamic cycles. Text, Ennis' *Applied Thermodynamics for Engineers.*

4.—STEAM AND GAS ENGINEERING IV. Fall term. Lectures and recitations, three hours; laboratory, two hours. Four credits. Prerequisite: Steam and Gas Engineering III.

A continuation of the work given in Steam and Gas Engineering III, including thermodynamic design of reciprocating steam engines, turbines, and internal-combustion motors, heat-engine economics and specifications. Text, same as Steam and Gas Engineering III, and notes.

5.—STEAM AND GAS ENGINEERING V. Winter term. Lectures and recitations, three hours; laboratory, two hours. Four credits. Prerequisite: Steam and Gas Engineering IV.

The course includes a study of solid, liquid and gaseous fuels for use in internal-combustion engines; of methods of refining crude petroleum; of manufacture of water gas, producer gas, coal gas, oil gas, including various scrubbing systems and gas-plant auxiliaries; of thermodynamic and physical properties of various commercial gases.

6.—STEAM AND GAS ENGINEERING E-I. Fall term. Lectures and recitations, four hours; laboratory, two hours. Five credits. Prerequisites: Kinematics; Calculus III.

This is a descriptive study of steam engines, boilers, and steam power-plant auxiliaries. The course includes a study of elementary thermodynamic principles of gases and vapors. Text, Allen & Bursley's *Heat Engines.*

7.—STEAM AND GAS ENGINEERING E-II. Winter term. Lectures and recitations, four hours; laboratory, two hours. Five credits. Prerequisite: Steam and Gas Engineering E-I.

Elementary thermodynamic principles applied to the study of the internal-combustion engine, and a descriptive study of gas engines, oil engines, and gas producers. Selection of prime movers for electric power plants, and the economics of the electric power-plant prime mover. Text, Jones' *Gas Engines.*

8.—STEAM AND GAS ENGINEERING C. Fall term. Lectures and recitations, three hours; laboratory, two hours. Four credits. Prerequisites: Kinematics; Calculus III.

A descriptive study of steam boilers, steam engines, steam turbines, and gas and oil engines, including the various auxiliaries. Text, Allen & Bursley's *Heat Engines.*

9.—FARM MOTORS I. Winter term. Lectures and recitations, two hours; laboratory, four hours. Four credits.

A descriptive study of steam engines, boilers, gas and oil engines, with special reference to their utilization on the farm. Text Potter's *Farm Motors.*

10.—FARM MOTORS II. Lectures and recitations, two hours; laboratory, two hours. Three credits. Prerequisite: Farm Motors I.

A continuation of the study of farm motors, including water motors, windmills, electric motors, and traction engines. Text, Potter's *Farm Motors.*

11.—TRACTION ENGINES. Lectures and recitations, one hour; laboratory, four hours. Three credits. Prerequisite: Farm Motors II.

A study is made of the details of construction, operation and testing of the various types of steam and oil traction engines.

12.—REFRIGERATION. Spring term. Lectures and recitations, two hours; laboratory, two hours. Three credits. Prerequisite: Steam and Gas Engineering IV, or Steam and Gas Engineering E-II.

This is a study of the practical details of compression and absorption refrigerating systems, including auxiliaries, refrigerating mediums, insulation, and applications of refrigeration to ice-making, cold storage, and the cooling of air, liquids, and solids. Text, Macintire's *Refrigeration.*

13.—POWER PLANT ENGINEERING. Winter term. Lectures and recitations, two hours. Two credits. Prerequisites: Steam and Gas Engineering IV; Hydraulic Machinery.

A study of complete power plants, including steam-electric, gas-electric, and hydro-electric power plants. In this course the knowledge obtained, through the study of the various prime movers and auxiliaries, is applied to the complete power plant. Text: Meyers' *Power Plants;* and notes.

14.—POWER PLANT DESIGN. Drafting room work, four hours. Two credits. Prerequisite: Power Plant Engineering.

A design of a complete power plant, including the location of prime movers and auxiliaries. In connection with this course the student makes a careful study of load conditions, location of plant, and other details.

15.—Heating and Ventilation. Spring term. Lectures and recitations, two hours; laboratory and drafting room work, two hours. Three credits. Prerequisite: Steam and Gas Engineering IV.

This course is planned to acquaint the students with the fundamental principles of heating and ventilation, including direct and indirect systems, hot water, hot air, and steam systems of heating; advantages of various heating systems. In the designing room heating systems for dwellings, shops, power plants, and schools are considered. Text, Hoffman's *Heating and Ventilation*

COURSES IN STEAM AND GAS ENGINEERING LABORATORY

Text, Carpenter and Diederich's *Experimental Engineering.*

1.—Steam and Gas Engineering II Laboratory. Winter term. Two hours a week. One credit. This must be taken in connection with Steam and Gas Engineering II.

This course includes the study and testing of gauges, indicators, simple steam engines and steam engine auxiliaries. Valve setting and manipulation of steam engines.

2.—Steam and Gas Engineering III Laboratory. Spring term. Two hours a week. One credit. This must be taken in connection with Steam and Gas Engineering III.

Calibration and use of calorimeters, traps, injectors. Flue gas analysis, manipulation and testing of gas and oil engines are the studies of this course. Prerequisite: Steam and Gas Engineering II Laboratory.

3.—Steam and Gas Engineering IV Laboratory. Fall term. Two hours a week. One credit. This must be taken with Steam and Gas Engineering IV.

This course includes thermal analyses of solid, liquid and gaseous fuels; engine and boiler room practice; evaporation tests on boilers; complete tests of steam engines and turbines; A. S. M. E. codes. Prerequisite: Steam and Gas Engineering III Laboratory.

4.—Steam and Gas Engineering V Laboratory. Winter term. Two hours a week. One credit. This must be taken with Steam and Gas Engineering V.

Complete tests are made on gas and oil engines, gas producers, water gas plants. Research work is done on explosive mixtures with various gas engine fuels. Air compressors, fans and blowers are also tested.

5.—Steam and Gas Engineering E-I Laboratory. Fall term. Two hours. One credit. This is taken in connection with Steam and Gas Engineering E-I.

This course includes the testing of indicators, gauges, steam engines; the use of steam calorimeters and steam meters; valve setting and manipulation of steam engines.

6.—Steam and Gas Engineering E-II Laboratory. Winter term. Two hours. One credit. Taken in connection with Steam and Gas Engineering E-II.

The course comprises manipulation and testing of gas and oil engines; engine room and boiler room practice; evaporation tests of steam boilers, steam turbine tests. Prerequisite: Steam and Gas Engineering E-I Laboratory.

7.—Steam and Gas Engineering C Laboratory. Fall term. Two hours. One credit. This is taken in connection with Steam and Gas Engineering C.

This course includes the handling of steam and gas engines; boiler and engine room practice; the use of steam calorimeters, indicators; simple tests on steam and gas engines.

8.—Farm Motors I Laboratory. Winter term. Four hours. Two credits. This is taken in connection with Farm Motors I.

A study is made of the construction, manipulation and testing of various types of farm motors, including steam engines and boilers, gas and oil engines, water motors, and windmills.

9.—Farm Motors II Laboratory. Spring term. Two hours. One credit. Taken in connection with Farm Motors II.

This is a continuation of the work given in Farm Motors I Laboratory, including the operation of electric motors and traction engines. Prerequisite: Farm Motors I Laboratory.

10.—Traction Engine Laboratory. Fall term. Four hours. Two credits.

The course comprises the operation and testing of steam and oil traction engines for belt work, road work, and field work. Prerequisite: Farm Motors II and laboratory.

11.—Refrigeration Laboratory. Spring term. Two hours. One credit. This must be taken with Refrigeration.

Part of the time is given to tests on refrigerating mediums and tests on refrigerating and ice making plants. The second half of the term is devoted to a design of a refrigerating plant.

12.—Gas Engines. Elective. Fall, winter, or spring term. Lecture, one hour; laboratory, four hours. Three credits.

This course is designed to teach the operation, care and repair of small stationary gas and oil engines.

SHORT COURSES IN MECHANIC ARTS

The following short courses are intended for men who wish to gain a practical knowledge of the work indicated. Each of the courses is ten weeks long, and is offered in the winter term.

SHORT COURSE IN STEAM AND GAS TRACTION ENGINES.

This course is intended for those who have not the time or the means to take any of the regular technical engineering courses in the College, but who wish to obtain a practical working knowledge of stationary and traction steam and gas engines. The work of the course is shown in the following tabulation:

Steam Engines, Boilers, and Steam Traction Engines	8 (2-12)
Gas Engines and Gas Traction Engines	7 (1-12)
Blacksmithing	3 (1-4)
Machine Shop Practice	4 (0-8)
Mechanical Drawing	2 (0-4)

SHORT COURSE IN SHOP WORK

This is a course designed for men who wish to gain a working knowledge of machines, tools, and methods which are used in the general repair shops. The subjects taught are shown below.

Blacksmithing
6 (2-8)
Foundry
3 (1-4)
Machine Shop
6 (0-12)
Woodwork
4 (0-8)
Gas and Oil Engines
3 (1-4)
Mechanical Drawing
2 (0-4)

SHORT COURSE IN CEMENT CONCRETE CONSTRUCTION

This course is designed for builders and others wishing to gain a general practical knowledge of concrete construction. The subjects considered are as tabulated here.

Concrete Construction
9 (3-12)
Concrete Materials and Tests
4 (1-6)
Concrete Drawing and Design
3 (0-6)
Form Construction and Framing
3 (1-4)
Gas Engines and Concrete Mixers
3 (1-4)
Mechanical Drawing
2 (0-4)

SHORT COURSE IN ROAD BUILDING, IRRIGATION AND DRAINAGE

This course, a tabulation of which is shown below, is designed for county engineers and surveyors.

Surveying
3 (1-4)
Highway Engineering
3 (3-0)
Irrigation and Drainage Engineering
3 (3-0)
Road Machinery and Materials Laboratory
2 (0-4)
Bridge and Culvert Construction
6 (3-6) .
Concrete Construction
3 (1-4)
Specifications and Contracts,
Road Laws and Administration
2 (2-0)
Mechanical Drawing
2 (0-4)

SUBJECTS TAUGHT IN THE MECHANIC ARTS SHORT COURSES

CONCRETE

1.—Concrete Construction. Class work, three hours; laboratory, twelve hours.

Instruction in the selection of materials and proper proportions for different kinds of concrete construction, and in the essential principles of forming for, and of mixing and placing concrete.

Laboratory work consists of practice in the making of a variety of concrete objects, as fence posts, building blocks and other molded specimens, of concrete sidewalks, floors, water tanks, machine foundations, of stucco and plastered work, etc.

2.—Concrete Materials and Tests. Class work, one hour; laboratory, six hours.

A study of properties and tests of cement, sands, gravels and broken stone. Standard tests are made to determine the fineness, soundness and strength of cement, the percentage of voids and foreign matters in sand and stone and the effect of variation in these properties upon the strength of concrete.

3.—Concrete Drawing and Design. Drafting room practice, six hours.

Exercises in drawing designed to teach the student to read simple working drawings and to enable him to make such drawings of simple proposed constructions, especially of concrete. Practice in the use of rules and tables to determine the size of beams, slabs, and columns, and the amount of reinforcing required in reinforced concrete.

STATIONARY AND TRACTION STEAM AND GAS ENGINES

1.—Steam Engines, Boilers, and Steam Traction Engines. Class work, three hours; laboratory, twelve hours.

A study of steam boilers and auxiliaries; types of boilers, grates for boilers, piping, pipe fittings, valves, putting in flues, steam gages, steam traps, pumps and injectors, firing, management of boilers. Stationary steam engines; types of engines, valves and valve setting, engine auxiliaries, installation, repairs and care of steam engines. Traction engines; fundamental parts, differentials, care and management of traction engines.

2.—Gas Engines and Gas Traction Engines. Class work, two hours; laboratory, eight hours.

A study of gas and oil engines; four-stroke, and two-stroke cycle engines, gas engine fuels, carbureters, ignition systems, selection, erection, and care of gas engines; gas engine repairs. Gas Traction engines.

3.—Gas and Oil Engines. Class work, one hour; laboratory, four hours.

A study of two-stroke and four-stroke cycle gas and oil engine; fuels; mechanical details. Selection and handling of gas and oil engines.

SHOP WORK

1.—Blacksmithing. (For Short Course in Shop Work.) Two hours of class work; eight hours of laboratory work a week.

A course in the forging of iron and steel such as will give a general knowledge of the methods of working and handling these metals. The class work will consist of a study of the manufacture of cast iron, wrought iron, mild steel, and of the proper use and method of working each.

2.—Blacksmithing. (For Short Course in Traction Engines.) Class work one hour; laboratory, four hours. Three credits.

This is a course in iron and steel work designed to give the student a knowledge of the manufacture of iron and steel and the proper methods of handling it in the forge shop. Exercises are given in drawing, upsetting, bending, twisting, punching, welding in iron and machinery steel, and also exercises in forging, hardening and tempering tool steel.

3.—Machine Shop. (For Short Course in Shop Work.) Shop work supplemented by lectures, sixteen hours a week.

A course in machine work to give a good working knowledge of a variety of machine operations such as chipping, filing, scraping, drilling, shaper and planer work, lathe work in cutting various threads, keyseating, soldering, brazing, babbitting, lacing belts, aligning shafting and pulleys, cutting and threading pipe, and in making general repairs on a variety of machinery.

4.—Machine Shop. (For Short Course in Traction Engines.) Laboratory, eight hours.

This course in machine work is to give the student practice in chipping, filing, drilling, babbitting and adjusting bearings, and in making general repairs to machinery; practice will also be given in cutting and fitting pipes, and in soldering and brazing, belt lacing, etc.

5.—Foundry. Class work, one hour; laboratory, six hours.

This course consists of bench and floor molding, with a great variety of patterns, along with which the student gets experience with different kinds of sand and facings; also, open sand work, sweep molds, and instruction in machine molding, core making, setting of cores, gates and risers, and different methods of venting, etc. The lectures consist of practical talks on the materials used in the foundry, the selection of sand, methods of venting, drying and handling of molds, cores, etc., for the various classes of work; also discussions on the handling of the cupola, and the grading and mixing of the irons suitable for different classes of work. Special emphasis in all cases being laid upon the practical side of work.

6.—Woodwork. Laboratory, eight hours.

Elementary principles of carpentry, framing and cabinet work.

7.—Form Construction and Framing. Class work, one hour; laboratory, four hours.

A study of the fundamental factors to be taken into consideration in the construction of buildings, as the building site, laying out and squaring the foundation, excavating, types of foundations, form building for concrete, anchoring, placing of sills, joists, bridging, studding, bracing, rafter cutting and fitting.

The laboratory work consists of exercises along the lines given above.

MECHANICAL DRAWING

Mechanical Drawing. Drafting-room practice, four hours.

An elementary course in mechanical drawing designed to teach students to read and interpret simple working drawings and to make working drawings of simple objects or designs. Some attention is devoted to the use of the triangles, T-square, and drawing instruments, and to the principles of orthographic projection.

ROAD BUILDING, IRRIGATION AND DRAINAGE

1.—Surveying. Class work, one hour; field work, four hours. Three credits.

This is a brief course in the care and use of engineers' surveying instruments. The greater part of the time is devoted to exercises and practical problems involving the use of the transit and level.

2.—HIGHWAY ENGINEERING. Class work, three hours. Three credits. The work in the class room is devoted to a study of the theory and practice of economic highway and pavement construction and maintenance, including a study of the needs of traffic, of its effect on the road surface, and of the materials of construction.

3.—IRRIGATION AND DRAINAGE ENGINEERING. Class work, three hours. Three credits.

In this course a study is made of the application of engineering principles to the design and construction of drainage and irrigation works. Considerable attention is paid to the development of ground water supplies for irrigation. Any senior engineering student may enter the course.

4.—BRIDGE AND CULVERT CONSTRUCTION. Three recitations; four hours in the drafting room. Five credits.

This is an elementary course in the design and construction of highway bridges and culverts.

5.—SPECIFICATIONS AND CONTRACTS, ROAD LAWS AND ADMINISTRATION. Class work, two hours.

A brief treatment of the road laws and administration in the various parts of the United States and Europe, dealing with specifications for various types of highway construction and the fundamental considerations to be dealt with in the formation of contracts.

6.—ROAD MACHINERY AND MATERIALS LABORATORY. Laboratory practice, four hours.

A study of the use of various road building machines and the testing of various road materials.

Mechanic Arts in the Summer School

The College has been unable to supply from its regular graduates all of the teachers in manual training required by the high schools of the State, and in order to encourage the introduction of manual training and industrial drawing in all grades the College offers summer courses for teachers in manual training, agriculture, and domestic science.

The work in drawing is an elementary course in free-hand and object drawing especially designed to assist teachers in the use of the state text in drawing.

In manual training and shop practice several courses are offered, embracing different grades of work and different materials. One of these is for pupils in the primary grades, and includes weaving, cord work, raffia, reed work and cardboard construction. Other courses deal with woodworking for the grammar grades and for high schools. These include not only a careful study of tools and processes, and practice in important exercises in joinery, but practical cabinet construction, wood turning, wood carving and inlaying, polishing and finishing.

In metal work a course in forging includes practical exercises for high-school work, involving the operations of drawing, upsetting, welding, twisting, splitting and shaping. Sufficient instruction is given in the forging of tool steel to enable one to make and temper many of the tools needed in high-school work. Another course includes bench work and machine-tool work, and familiarizes the student with some of the fundamental operations of a modern machine shop.

A special circular giving further details of this work may be had upon application to the President of the College. See, also, article in this pamphlet on the Summer School.

Engineering Fellowships

The Board has established two fellowships in engineering. Each fellowship is two years in duration. The holder is expected to devote eleven months of the year to the work laid out, and receives from the College $500 annually.

To be eligible for appointment, the applicant must be a graduate of a technical course of a school or college of recognized standing. Preference will be given to those who have had some commercial experience along the lines of research to be followed.

Applications for fellowships should be made to the dean of the Division of Mechanic Arts, and should state the lines of work that the applicant particularly desires to follow.

The Engineering Experiment Station

The Engineering Experiment Station was established for the purpose of carrying on continued series of tests of engineering and manufacturing value to the State of Kansas, on a scale sufficiently large for the results to be of direct commercial value.

Tests of cement and concrete are being conducted, using principally Kansas-made cements and such materials for the aggregate in the concrete as can be found in different localities in the State. In connection with this series of tests, a study is being made of the waterproofing and coloring of cement building blocks.

Tests of Kansas coals are being made. These include mine-run, slack, nut, screened, lump, and washed-pea coals. The purpose is not only to determine the relative values of the different coals for steam generation, but more particularly to ascertain the best methods of firing the coals of each locality, and the relative values of the different kinds of coal obtained from any single mine. These tests are conducted with both natural and induced draft, the Station owning an induced-draft equipment and economizer.

The Station owns a 100-horsepower and a 150-horsepower gas producer using bituminous coal. Tests that have been carried on have been for the purpose of determining the relative values of the various coals as regards (1) cost per cubic foot of gas; (2) adaptability with respect to mechanical manipulation in the producer; (3) freedom from sulphur and disagreeable gases; (4) the production of tar and other by-products; special research.

The producer testing equipment includes calorimeters for the analysis of solid, liquid and gaseous fuels, a Venturi tube for the measurement of gas, a thermoelectric pyrometer, and such other apparatus as is essential for the carrying out of complete tests. Each test is conducted for a period of several weeks, in order to eliminate errors in the estimation of the coal and "stand-by" losses.

As there are but very few other plants in the country satisfactorily using bituminous coal for producer gas, it is believed that the experiments now being carried on will give valuable results.

Other experiments now in progress are concerned with (1) lubricants and bearings; (2) power required for driving machine tools; (3) loss of power in transmission by shaft, bearings, chains, and gears; (4) the relative adaptability, efficiency and cost of gasoline, kerosene and denatured alcohol for internal-combustion engines; (5) the cost of compressing air and the efficiency of compressed air for power purposes; (6) endurance of paints. As applied to roofs, the paint tests have been in progress for five years, and they will be extended to include other cases of exposure to weather. The investigation is directed especially to the relation of the chemical nature of the pigments and of the oils employed in painting to the durability of the paints. (7) Tests on pipe-covering; (8) tests on heavy-oil engines.

Among the projected investigations are (1) underground water-flow in various parts of the State, and methods of developing it for irrigation; (2) the possibilities of developing waterpower for small plants to be used on farms and in isolated communities for driving machinery, either directly or by electric transmission, and for lighting; this investigation to include the preparation and publication of plans for these plants; (3) the continuation of investigations as to the strength of structural details in timber, metal, and reinforced concrete; (4) studies of the tractive effect or efficiency of draught horses; (5) tests of small gasoline-electric units; (6) methods of cooling condensed steam; (7) tests of Kansas brick and other road material.

School of Agriculture

The School of Agriculture is organized to meet the needs of young men and young women of Kansas who may need instruction more closely identified with the life of the farm, home and shop than that provided by the high schools of the State. It is also intended to meet the needs of those men and women who find themselves for any cause unable to complete an extensive course of collegiate instruction, yet who feel the necessity of a practical training for their activities in life. More than one-half of the student's time in the school will be spent in the laboratories and in contact with the real objects of his future work.

The course in mechanic arts leads to a trade. It is designed to shorten the time of apprenticeship and to prepare the way for skilled workmanship in shop or factory. The great amount of time spent in the shops should easily lead to skill and efficiency in subsequent work.

ADMISSION

Students who are fourteen years of age or older and who have completed the eighth grade of the public schools are admitted without examination. Students who have not completed the eighth grade are examined in arithmetic, United States history, English grammar, geography, reading, and spelling. Students who have done work in the public high schools receive credit for the work done. Maturity in years and practical experience are given due consideration, but students should not consider these qualifications alone sufficient to admit them. Wherever there is question about a student's qualifications for entering, he should correspond with the Principal of the School of Agriculture before coming.

TIME OF OPENING

All candidates for admission to the School of Agriculture should present themselves for registration at the College September 14 to 17, inclusive. The Principal of the School of Agriculture is charged with the execution of all College and Faculty rules relating to the enrollment of students in classes and their choice of studies.

Trade Practice in Mechanic Arts Course

(School of Agriculture.)

Trade Practice in Blacksmithing

FIRST YEAR

FALL	WINTER	SPRING
		Machine Shop I-S 3 (0-6)

SECOND YEAR

Blacksmithing II-S 3 (1-4)	Blacksmithing III-S 3 (0-6)	Blacksmithing IV-S 3 (0-6)
Gas and Oil Engines I 3 (1-4)	Strength of Materials I 3 (3-0)	Strength of Materials II 3 (3-0)

THIRD YEAR*

Blacksmithing V-S 6 (0-12)	Blacksmithing VI-S 6 (1-10)	Blacksmithing VII-S 8 (2-12)
Electricity I-S 3 (2-2)	Machine Shop II-S 3 (0-6)	Concrete Construction I 3 (1-4)
Elements of Mechanism 3 (3-0)	Steam Engines and Boilers I 3 (1-4)	Elective 3 (-)

Trade Practice in Carpentry

FIRST YEAR

FALL	WINTER	SPRING
		Wood Turning 3 (0-6)

SECOND YEAR

Bench Work 3 (1-4)	Form Const. and Framing 3 (1-4)	Inside Finishing 3 (1-4)
Gas and Oil Engines I 3 (1-4)	Strength of Materials I 3 (3-0)	Strength of Materials II 3 (3-0)

THIRD YEAR*

Building Construction I 6 (2-8)	Building Details 9 (2-14)	Building Construction II 8 (2-12)
Shop Drawing IV 3 (0-6)	Estimating 3 (0-6)	Concrete Construction I 3 (1-4)
Electricity I-S 3 (2-2)		Elective 3 (-)

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* No third-year trade practice work will be offered in any course during the college year 1914-1915.

Trade Practice in Cement and Concrete Construction

FIRST YEAR

FALL	WINTER	SPRING
		Concrete Construction I 3 (1-4)

SECOND YEAR

FALL	WINTER	SPRING
Cement and Aggregate Tests 3 (0-6)	Strength of Materials I 3 (3-0)	Strength of Materials II 3 (3-0)
Cements and Aggregates 3 (3-0)	Form Const. and Framing 3 (1-4)	Concrete Construction II 3 (0-6)

THIRD YEAR*

FALL	WINTER	SPRING
Electricity I-S 3 (2-2)	Machine Shop I-S 3 (0-6)	Carpentry 3 (0-6)
Structural Drawing 3 (0-6)	Steam Engines and Boilers I 3 (1-4)	Gas and Oil Engines I 3 (1-4)
Plain Concrete Design 3 (0-6)	Concrete Construction III 3 (1-4)	Forms and Centering 3 (1-4)
Structural Materials Tests 3 (0-6)	Reinforced Concrete Design 3 (0-6)	Concrete Construction IV 3 (1-4)

Trade Practice in Gas Engines

FIRST YEAR

FALL	WINTER	SPRING
		Gas Engines I 3 (1-4)

SECOND YEAR

FALL	WINTER	SPRING
Steam Engines and Boilers I 3 (1-4)	Gas Engines III 3 (1-4)	Gas Engines IV 3 (1-4)
Gas Engines II 3 (1-4)	Machine Shop I-S 3 (0-6)	Machine Shop II-S 3 (0-6)

THIRD YEAR*

FALL	WINTER	SPRING
Pipe Fitting 3 (0-6)	Gas Engines V 3 (0-6)	Gas Engines VI 3 (0-6)
Concrete 3 (0-6)	Electricity II-S 6 (3-6)	Electricity III-S 6 (3-6)
Traction Engines I 3 (0-6)	Strength of Materials I 3 (3-0)	Strength of Materials II 3 (3-0)
Elements of Mechanism 3 (3-0)		

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* No third-year trade practice work will be offered in any course during the college year 1914-1915.

Trade Practice in Steam Engines and Boilers

FIRST YEAR

FALL	WINTER	SPRING
		Steam Engines and Boilers I 3 (1-4)

SECOND YEAR

FALL	WINTER	SPRING
Steam Engines and Boilers II 3 (1-4)	Steam Engines and Boilers III 3 (1-4)	Steam Engines and Boilers IV 3 (1-4)
Gas and Oil Engines I 3 (1-4)	Machine Shop I-S 3 (1-4)	Machine Shop II-S 3 (1-4)

THIRD YEAR*

FALL	WINTER	SPRING
Elements of Mechanism 3 (3-0)	Steam Engines and Boilers V 3 (0-6)	Steam Engines and Boilers VI 3 (0-6)
Traction Engines I 3 (0-6)	Electricity II-S 6 (3-6)	Electricity III-S 6 (3-6)
Pipe Fitting 3 (0-6)	Strength of Materials I 3 (3-0)	Strength of Materials II 3 (3-0)
Concrete 3 (0-6)		

Trade Practice in Traction Engines

FIRST YEAR

FALL	WINTER	SPRING
		Traction Engines I 3 (1-4)

SECOND YEAR

FALL	WINTER	SPRING
Steam Engines and Boilers I 3 (1-4)	Traction Engines II 3 (1-4)	Traction Engines III 3 (1-4)
Gas and Oil Engines I 3 (1-4)	Machine Shop I-S 3 (1-4)	Machine Shop II-S 3 (1-4)

THIRD YEAR*

FALL	WINTER	SPRING
Elements of Mechanism 3 (3-0)	Traction Engines V 3 (0-6)	Traction Engines VI 3 (0-6)
Traction Engines IV 3 (0-6)	Electricity II-S 6 (3-6)	Electricity III-S 6 (3-6)
Concrete 3 (0-6)	Strength of Materials I 3 (3-0)	Strength of Materials II 3 (3-0)
Pipe Fitting 3 (0-6)		

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* No third-year trade practice work will be offered in any course during the college year 1914-1915.

The Summer School

EDWIN LEE HOLTON, Director

There is no larger or better equipped plant devoted to the teaching of agriculture, home economics, mechanic arts, and related subjects than Kansas has in her State Agricultural College. In order that this plant may not remain idle during the summer, the Board of Administration has authorized the organization of a Summer School for Teachers. The College is authorized by an act of Congress to expend each year a portion of the national appropriation for "providing sources for the special preparation of instructors for teaching the elements of agriculture and mechanic arts."

Each year there is an increasing demand for trained teachers of agriculture, shop work, and home economics. The College has not been able to supply this demand. The Summer School offers an opportunity for experienced teachers to prepare themselves to meet the new demands placed upon the public schools, viz., preparing the boys and girls for vocational and social efficiency.

ADVANTAGES AT THE KANSAS STATE AGRICULTURAL COLLEGE.

For the training of teachers in vocational subjects the Kansas State Agricultural College has a peculiar advantage. The College campus occupies a commanding and attractive site upon an elevation adjoining the western limits of the city of Manhattan, with electric car service into town and to the railway stations. The grounds are tastefully laid out according to the designs of a landscape architect, and are extensively planted with a great variety of beautiful and interesting trees, arranged in picturesque groups, masses and border plantings, varied by banks of shrubbery and interspered with extensive lawns, gardens and experimental fields. Broad, macadamized and well-shaded avenues lead to all parts of the campus. Including the campus of 160 acres, the College owns 748 acres of land. Outside the campus proper, all the land is devoted to practical and experimental work in agriculture. Within the College grounds most of the space not occupied by buildings or needed for drives and ornamental planting is devoted to orchards, forest and fruit nurseries, vineyards, and gardens.

The College buildings, twenty-one in number, are harmoniously grouped, and are uniformly constructed of attractive white limestone obtained from the College quarries. The College owns and operates its own system of waterworks, and is provided with a complete sewerage system.

There is a growing conviction among the leading educators that the best institution in which to train teachers of vocational subjects is a well-equipped technical college, where the courses of study are pointed towards the producing vocations. The Kansas State Agricultural College is such an institution.

EXPENSES

Tuition is free. An incidental fee of $3 and a medical fee of 50 cents a term are charged all students whose homes are in Kansas. For nonresidents of the State a matriculation fee of $10 upon entrance and an incidental fee of $10 and a medical fee of 50 cents a term are charged. Receipts for these fees must be presented before enrollment in the College classes. Table board varies from $3.50 to $4 a week. Room rent ranges from $8 to $12 a month. The College Young Men's Christian Assocation offers accommodations in its building for a limited number of students, at prices from $10 to $12 per month. The cost of rooms is reduced by half where two students room together.

COLLEGE CREDITS

Full College credit is given for all courses satisfactorily completed by regularly matriculated students unless otherwise specified in the announcement of the courses. Students desiring College credit are not allowed to carry more than ten credit hours; provided, that an exceptionally able student may be permitted to carry two additional credit hours upon the approval of the Director of the Summer School.

REQUIREMENT FOR ADMISSION

Four years of high-school work are required for admission to the College, but any applicant holding a teacher's certificate will be admitted to the courses for the Summer School without examination.

The following classes of applicants will be admitted:

1. Students already enrolled in the College.
2. Graduates of high schools that have four-year courses of study.
3. Any persons holding certificates to teach in the state of Kansas.
4. Prospective teachers who are not graduates of four-year high schools and who do not hold teachers' certificates may be admitted as special students.

CONVOCATION

The hours from ten to eleven on Thursday morning are reserved for general assembly of all students. A special address and music are arranged for each of these general assembly periods.

LIBRARY

The Library is open during the summer. The Librarian places all the valuable books, bulletins and reports at the service of the Summer School students.

EDUCATIONAL TRIPS

Trips are arranged, for those who desire to take them, to the experimental grounds on the College farm and campus, to study the work in progress. These trips are under the leadership of trained men.

Courses in the Division of Mechanic Arts

A. A. POTTER, Dean

DRAWING AND ART

Miss HOLMAN

PUBLIC SCHOOL DRAWING. Laboratory course, eight hours.
This course presents free-hand and object drawing and some watercolor and crayon work for rural and grade schools. The state text in drawing is used and the course is especially designed to be helpful to teachers in using these books.

COLOR AND DESIGN I. Laboratory course, eight hours.
This course consists of a study of color combinations based on spectral color. It includes the development of problems illustrating changes of hue and value. The principles of design are also developed by problems and closely related to the color studies. A notebook is required to be kept, consisting of outlines given by the instructor and of original work of the student.

COLOR AND DESIGN II. Laboratory course, eight hours.
This course continues the study of the principles of color and design. Practical applications to dress and to home environment are made.

NOTE.—Color and Design II must be preceded by course I, and will not be given unless a sufficient number of students with preliminary training present themselves.

MANUAL TRAINING

Assistant Professor BRAY

MANUAL TRAINING METHODS AND ORGANIZATION. Class work, four hours.
A course dealing with the history of manual training in the United States, as well as a similar development in foreign countries. A study is made of the different systems, the various forms of hand work, and the grades to which they are best adapted; the equipment and material required for each of the various lines of work, together with their cost and where they can be secured; also the best arrangement of equipment and its proper installation. The course will include lectures, recitations, discussions, reading, and written reports.

MANUAL TRAINING FOR PRIMARY GRADES. Laboratory, ten hours.
This course is designed to give instruction to teachers in those forms of hand work that have been found most profitable in the lower grades. The possibilities and adaptations of the different mediums are studied and methods of teaching the work are carefully considered. This work will include weaving, cord work, raffia, reed work, and cardboard construction. Lectures, discussions, and reports.

MECHANICAL DRAWING

Professor SEATON
Assistant BOWERMAN

MANUAL TRAINING DRAWING. Drafting, eight hours. No credit.

Instruction and practice in lettering and the use of instruments. Isometric and orthographic projection drawings are made of manual training problems. Practice is also given in tracing and blue-printing.

MECHANICAL DRAWING I. Class work, two hours; drafting, four hours. Two credits. Required of all students in engineering courses.

The course includes the use and care of drawing instruments, with simple exercises in making working drawings from given plates. Special attention is given to the arrangement of views to secure balance, and to the subject matter and layout of titles and notes.

The following supplies are required: Triangle, T-square, pencils, scale, pens, eraser, thumb tacks, drawing paper, and a set of drawing instruments. Students are advised not to purchase these supplies until after consulting the instructor. Text, French's Engineering Drawing.

MECHANICAL DRAWING II. Class work, two hours; drafting, eight hours. Three credits. Required of all students in engineering courses.

Free-hand sketches are made from simple machine parts, followed by complete working drawings from these drawings without further reference to the subjects. Special emphasis is laid upon the proper selection of views to present the necessary information in convenient form, and to the dimensioning of the drawings. Text, French's Engineering Drawing.

SHOP WORK

Associate Professor CARLSON
Instructor HOUSE
Instructor HOLLAR
Instructor HAYES
Instructor GRANT
Assistant PARKER
Assistant TRUMBULL
Assistant BALL

WOODWORKING FOR THE GRAMMAR GRADES. Ten hours, laboratory.

A careful study of the tools and processes used for woodworking for these grades. Lectures, discussions, and reports on methods of introducing and teaching this work. A course of suitable exercises for pupils of this age will be made, together with the construction of models, showing progressive steps, for class use.

WOODWORKING FOR THE HIGH SCHOOL. Ten hours, laboratory.

A course in woodworking for high schools, in which a number of the most important exercises in joinery are carried out, with a study of their application, after which a series of articles in practical cabinet construction are made, with a study of the proper method of ornamenting and finishing. Lectures, discussions and reports.

WOOD TURNING. Ten hours, laboratory.

A course designed to prepare teachers for teaching wood turning in high schools. The work includes typical application of tools and tool processes, in turning between centers, on faceplates, and by means of hollow chucks. Exercises are given in turning cylinders, cones, beads, convex and concave curves, after which articles are made from drawings, which have a practical application in a student's home or social life, such as handles, mallets, rolling-pins, circular boxes with covers, Indian clubs, dumb-bells, napkin rings, bowls, towel rings, typical vase forms, cups, goblets, frames, ornamental stools, etc. While many of these articles are made from blue prints, it is the aim to have the student make some objects of value from his own designs, both as a project in turning and as a practical lesson in designing.

In connection with the laboratory work a careful study is made of the commercial value of wood turning, kinds of wood suitable for this work, methods of polishing and finishing work in the lathe, together with a study of suitable power transmission, shafting, belting, tight and loose pulleys, proper speed, etc.

ADVANCED WOODWORKING. Ten hours, laboratory.
A continuance of Woodworking for the High School, in which an opportunity is furnished for taking more advanced cabinet construction, including wood carving and inlaying.

BLACKSMITHING I. Laboratory, ten hours.
In this course the field of hand-forging as related to high school is covered. The work includes practical exercises in making articles of use, which involves the operations of drawing, upsetting, welding, twisting, splitting, and shaping. Sufficient instruction is given the student in the forging of tool steel to enable him to make and temper many of the tools that will be needed in this and other branches of manual training in the high school. Lectures, discussions, and reports.

BLACKSMITHING II. Laboratory, ten hours.
Advanced work in the forging of iron and in the manufacture of tools, such as punches, chisels, drills, scrapers and hammers. Instruction is given in the proper methods of heating, forging, hardening, tempering, annealing and working the various kinds of tool steel, and in the case-hardening of mild steel.

BLACKSMITHING III. Laboratory, ten hours.
Special work is given in the forging of iron and steel to impart skill in the different operations. Some practice will be given in the making of ornamental iron work.

MACHINE SHOP I. Laboratory, ten hours.
This course includes both bench and machine tool work, in which practice is given in chipping, filing, shaper and planer work, scraping, drilling, cutting, right- and left-hand and multiple threads, and murling on the lathe. Lectures and discussions accompany the work, so that the fundamental principles are more easily grasped by the student.

MACHINE SHOP II.
This course consists of progressive problems in turning and calipering, boring, reaming and taper turning and threading on the lathe, exercises in chucking, the use of forming tools, practice on the key-seating machine, and the making of a spur gear on the milling machine. A study is also made of cutting edges and tool adjustments best suited to the different metals, together with a study of cutting speeds and feeds.

MACHINE SHOP III.
This course takes up work on the turret lathe, boring mill; practical work is also given with jigs and templates, and a study made of the rapid production of duplicate parts, belts, lacings, and methods of belt connections, compound and differential indexing, and the cutting of spiral gears on the milling machine.

NOTE.—The number of hours of credit in course offered in shop work will depend upon the amount and quality of work completed.

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